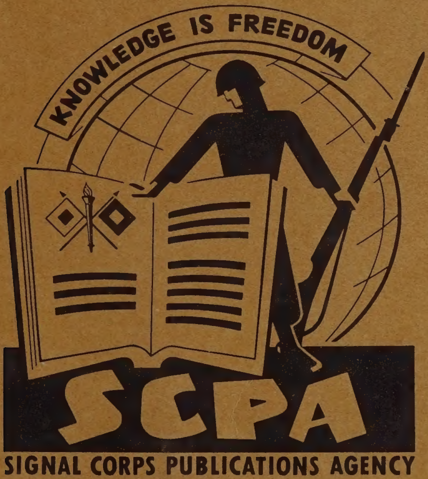
INSTRUCTION BOOK
for
RADIO TRANSMITTER T-278/U
and
RADIO TRANSMITTER T-416/GR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ADDENDA
25 JUNE 1953

ADDENDA NO. 4 TO INSTRUCTION BOOK FOR RADIO TRANSMITTER T-278/U AND RADIO TRANSMITTER T-416/GR

The following information, published on Order No. 11661-Phila-52, provides information to be added to the instruction book. These addenda supersede Addenda No. 1, 30 March 1953, Addenda No. 2, 15 May 1953, and Addenda No. 3.

Personnel using this equipment and having custody of these addenda will enter suitable notations beside each affected paragraph and figure in the instruction book to indicate the presence of this supplementary information.

Change "Case CY-1221/U" to read: Electrical Equipment Cabinet CY-1221/G, wherever it appears in the instruction book.

Change the type designation of tube V502 from "5894A" to read: 5894, wherever it appears in the instruction book.

Change "Power Supply PP-640/U" to read: Dynamotor-Power Supply DY-100/U, wherever it appears in the instruction book.

Change "Case CY-938/U" to read: Electrical Equipment Cabinet CY-938/VRC, wherever it appears in the instruction book.

Delete capacitors "C464" and "C465", wherever they appear in the instruction book.

Change the value of R410 from "10" to 15, wherever it appears in the instruction book.

Delete resistor R473, 4700 ohms, and replace it with r-f choke L411, 1.5 UH, in the following places in the instruction book:

Page 32. Fig. 19.
Page 38. Fig. 24.
Page 52. Fig. 29.
Page 73. Fig. 42.

Change "Radio Transmitter T-278( )/U" to read: Radio Transmitter T-278/U, wherever it appears in the instruction book.

Change the power output of Radio Transmitter T-278/U from "30 watts" to 25 watts, wherever it appears in the instruction book.

Change the power output of Radio Transmitter T-416/GR from "50 watts" to 45 watts, wherever it appears in the instruction book.

Change "HR 401" to read: E401, wherever it appears in the instruction book.

Change "patch cord" to read: Special Purpose Electrical Cable Assembly CX-2371/U (patch cord), wherever it appears in the instruction book.

Change the value of C463 from "500" to 510, wherever it appears in the instruction book.

Page 2. Fig. 2. Make the following changes in the block diagram for Radio Set AN/VRC-19(*), change "Electrical Equipment Cabinet CY-1221/G" to read: Electrical Equipment Cabinet CY-938/VRC.

In the block diagram for Radio Set AN/TRC-28, change "Amplifier AM-494/GR" to read: Radio Frequency Amplifier AM-494/GR.

Page 3. Par. 5. Opposite "Spurious emission", change "attenuated at least 70" to read: attenuated at least 50.

Page 4. Par. 5b. Opposite "Power supply", change "external d-c (direct-*** to Dynamotor DY-98/U" to read: External d-c (direct-current) operated Dynamotor-Power Supply DY-93/G, Dynamotor-Power Supply DY-98/G, or Dynamotor-Power Supply DY-100/U.

Page 7. Par. 16. Make the following changes in the "function" column.

12 lines from the bottom, change "Provides MIN and MAX coupling" to read: Provides adjustment of coupling.

10 lines from the bottom change "Acts as the antenna loading adjustment" to read: Acts as the antenna tuning adjustment.

3 lines from the bottom, add the following at the end of the sentence: (between two tubes or the sections of one tube).

Page 8. Par. 18d. Change "antenna to antenna" to read: antenna or r-f wattmeter to antenna.

Page 12. Par. 19. Make the following changes in paragraph 19:

In subparagraph c, line 9, change "two-thirds" to read: nine-tenths and on line 10, change "-3.5" to read: -5.

In subparagraph f, line 4, change "-75" to read: -70.

In subparagraph j, change "connect a voltmeter (1000 ohms per volt or better)" to read: Connect a voltmeter (1000 ohms per volt or better or a 1/4-ampere ammeter with .5 ohm or less resistance).

In subparagraph i, add the following at the end of the CAUTION: When using a voltmeter with a metal case across the PL CUR jacks, make sure that you do not touch the case of the meter. Both jacks are above ground potential.

Page 13. Par. 23a. Line 3. Delete "one oscillator tube filament and".

Page 14. Par. 27. Add the following "Caution" after subparagraph b:

Caution: Be sure to keep all dust covers tight and all cable entrances sealed to keep out dust.

Page 21. Par. 41e. Item 12. Normal condition column. Change "Filament power to oscillator tube and power to crystal heater" to read: Power to crystal heater is removed.

Page 23. Par. 43a(2). Line 11. Add the following to the last sentence: at 1,000 cycles modulating frequency.

Page 25. Par. 44d. Line 8. Change "C402, C403, and C465" to read: C402 and C403.

Page 25. Par. 44f. Delete the last sentence.

Page 26. Par. 45a. Lines 7 and 8. Delete "d-c blocking", and line 9, change "180°" to read: 90°.

Page 27. Figure 15. Make the following changes:

Add "**560K" below "R414 680K".

Add the following to the notes:

3. RESISTOR R414 IS 560K IN RADIO TRANSMITTER T-416/GR, BEGINNING WITH SERIAL NO. 1, AND IS 560K IN RADIO TRANSMITTER T-278/U BEGINNING WITH SERIAL NO. 496.

Page 27. Par. 46. Add the following to the end of the third sentence:

At 1,000 cycles modulating frequency.

Page 28. Fig. 16. Make the following changes in figure 16: Add the following to the notes:

3. *INDICATES VALUE OF COMPONENT IN RADIO TRANSMITTER T-416/GR.

ADD "*2200" AFTER "R421 1500", "R471 1K", AND "R422 1500".

4. **RESISTOR R414 IS 560K IN RADIO TRANSMITTER T-416/GR, BEGINNING WITH SERIAL NO. 1, AND IS 560K IN RADIO TRANSMITTER T-278/U BEGINNING WITH SERIAL NO. 496.

Add "**560K" below "R414 680K".

Page 30. Fig. 18. Make the following changes in figure 18:

Delete "C504 1500", above "R501 22K", and replace it below "R501 22K".

Change the values of R505 from "1500" to 2200 and R503 from "47K" to 15K.

Change "S501" to read: S502.

Page 31. Par. 47a. Lines 6 and 7. Delete "Resistors R440 and R473" substitute resistor R440 and r-f choke L411.

Line 9. Delete "Resistors R473 and" substitute resistor R439 and r-f choke L411.

Page 33. Fig. 20. Make the following changes in figure 20:

Change "R503 47K" to 15K, "R506 2200" to 22K and "R505 1500" to 2200.

Change "L506" to read: L506A, "L508" to read: L506B and remove the ground symbol from both.

Remove the left-hand wire, connecting C511, from ground, and connect it to pin 5 of V502. Ground the right-hand wire.

Page 34. Fig. 21. Make the following changes in figure 21: Reverse the reference symbols of R458 and R474 but leave the values as they are.

Add "See Note 3" at terminal 1 of transformer T401.

Add the following to the notes:

3. STARTING AT SERIAL NO. 1 OF RADIO TRANSMITTER T-416/GR, AND SERIAL NO. 601 OF RADIO TRANSMITTER T-278/U, THE GROUND SYMBOL IS REMOVED FROM TERMINAL 1 OF TRANSFORMER T401, AND A LEAD IS CONNECTED TO THE JUNCTION OF RESISTOR R434 AND CAPACITOR C426 NOT SHOWN ON SCHEMATIC.

Page 34. Par. 49. Line 17. Change "R458" to read: R474, and change "R474" to read: R458.

Page 35. Fig. 22. Make the following changes in figure 22:

Add the following to the notes:

NOTE 4. * INDICATES DIFFERENCE OF VALUE OF COMPONENTS IN RADIO TRANSMITTER T-416/GR.

5. BEGINNING WITH SERIAL NO. 1. OF RADIO TRANSMITTER T-416/GR, AND SERIAL NO. 601 OF RADIO TRANSMITTER T-278/U, THE LEAD BETWEEN TERMINAL 15 OF PLUGS P501, P401 AND R434 IS REMOVED AND CONNECTED TO TERMINAL 1 OF TRANSFORMER T401, WHICH IS REMOVED FROM GROUND.

Add "*2200" after "R421 1500", "R471 1K", and "R422 1500".

Change "R503" from "47K" to 15K and "R505" from "1500" to 2200.

Change "L506" to read: L506A, "L508" to read: L506B, and remove the ground symbol from both.

Delete the wire between pins 1 and 2 of V411, and insert R458 100K between pin 2 of V411 and the junction of R463, R462, and C462.

Delete "R458 470K" and the wire from pin 2 of V412, and insert a wire between pins 1 and 2 of V412.

Add "See Note 5" at terminal 15 of plug P501, P401.

Page 37. Fig. 23. Lower right-hand corner. Change terminal "7" of TB801 to read: 8, "29" at J803 and P252 to read: 28.

Page 38. Fig. 24. Make the following changes in figure 24:

Add "**560K" below "R414 680K".

Change "NOTE" to read: NOTES:, and put a 1. before the existing note, then add the following:

2. **RESISTOR R414 IS 560K IN RADIO TRANSMITTER T-416/GR BEGINNING WITH SERIAL NO. 1 AND IN RADIO TRANSMITTER T-278/U BEGINNING WITH SERIAL NO. 496.

Change R504 "3300" to read: 4700.

Page 39. Par. 52. Make the following changes in paragraph 52:

Add the following at the end of subparagraph c: On serial numbers 1 thru 600 on Radio Transmitter T-278/U only.

Add subparagraph d after subparagraph c.

d. On Radio Transmitter T-416/GR beginning with serial No. 1, and on Radio Transmitter T-278/U beginning with serial No. 601, the final +2 volts d-c output at the voltage divider is connected to terminal 1 of transformer T401 to supply the microphone current.

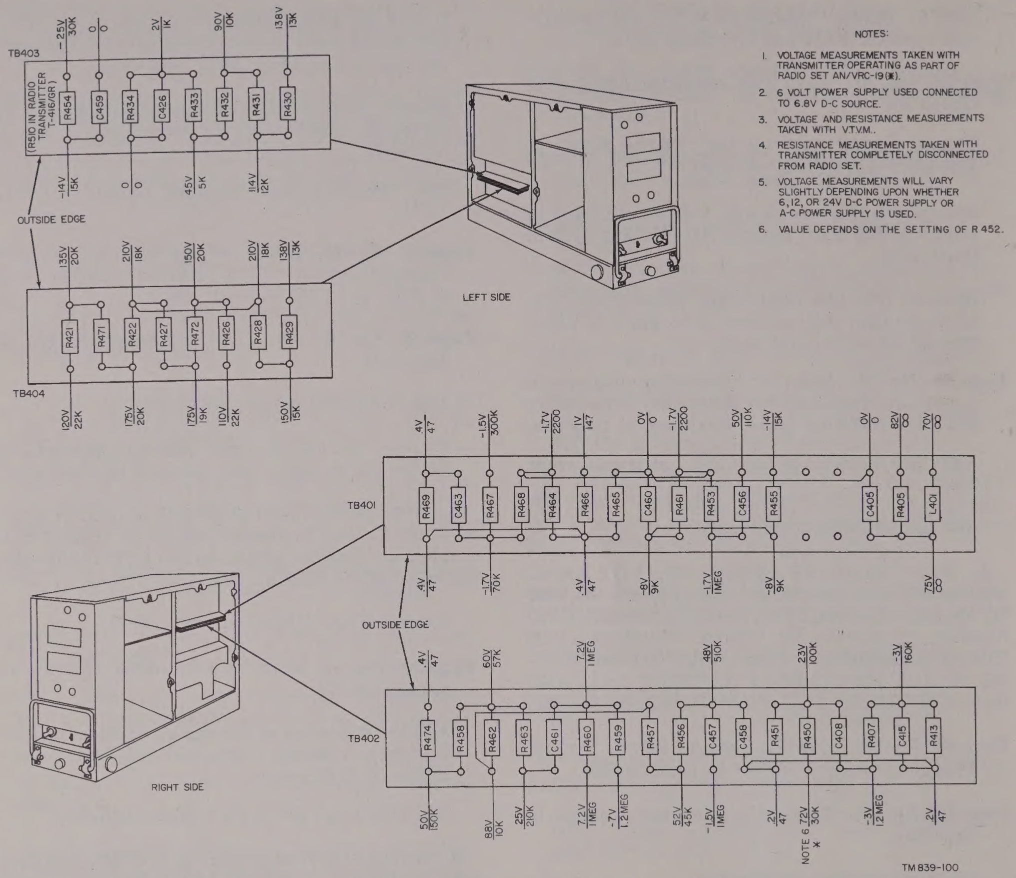
Page 40. Fig. 25. Note 2. Item 3. Change "Power Supply PP-869/U" to read: Dynamotor-Power Supply DY-100/U.

Page 48. Par. 64. Transformer or coil column. Add the following between "L401 & L412": L411 - - - - .1 (continuity).

Page 49. Fig. 26. Make the following changes in figure 26: Change "P436" to read: C436.

Change "R411" (called out between C418 and C419), to read: R416.

Page 50. Fig. 27. Make the following changes in figure 27: Reverse reference symbols "V410" and "V409".


TB403
(R510 IN RADIO TRANSMITTER T-416/GR)
R454
C459
R434
C426
R433
R432
R431
R430
OUTSIDE EDGE
TB404
R421
R471
R422
R427
R472
R426
R428
R429
LEFT SIDE
TB401
R469
C463
R467
R468
R464
R466
R465
C460
R461
R453
C456
R455
C405
R405
L401
OUTSIDE EDGE
TB402
R474
R458
R462
R463
C461
R460
R459
R457
R456
C457
C458
R451
R450
C408
R407
C415
R413
RIGHT SIDE
NOTE 6 *
TM 839-100

NOTES:

1. VOLTAGE MEASUREMENTS TAKEN WITH TRANSMITTER OPERATING AS PART OF RADIO SET AN/VRC-19 (*).
2. 6 VOLT POWER SUPPLY USED CONNECTED TO 6.8V D-C SOURCE.
3. VOLTAGE AND RESISTANCE MEASUREMENTS TAKEN WITH V.T.V.M..
4. RESISTANCE MEASUREMENTS TAKEN WITH TRANSMITTER COMPLETELY DISCONNECTED FROM RADIO SET.
5. VOLTAGE MEASUREMENTS WILL VARY SLIGHTLY DEPENDING UPON WHETHER 6, 12, OR 24V D-C POWER SUPPLY OR A-C POWER SUPPLY IS USED.
6. VALUE DEPENDS ON THE SETTING OF R 452.

Figure 36. Radio Transmitter T-278/U and T-416/GR voltages and resistances at terminal boards.

Change "C418" to read: C412.

Page 52. Fig. 29. Add the following to figure 29: Place an arrow with the callout C428 pointing just below the lower left-hand corner of C429.

Place an arrow with the callout C440 pointing between sockets XV409 and XV410.

Page 53. Fig. 30. Change "Z406" to read: Z407, and "C449" to read: C445.

Page 55. Fig. 33. Change "J503" to read: J504 and "J504" to read: J503.

Page 56. Fig. 34. Change "Z406" to read: Z407.

Page 57. Fig. 35. Make the following changes in figure 35: Change "430V" at plates of tube V502, to read: 480V.

Change "45K" at pin 5 of tubes V409 and V410 to read: 40K.

Change "20K" at pin 7 of tube V406 to read: V411.

Page 59. Fig. 36. Delete figure 36 and substitute the new figure 36.

Page 73. Fig. 42. Make the following changes in figure 42: Reverse the reference symbols of R458 and R474 but leave the values as they are.

Change the values of C429, C437, C439, and C451 from "25" to 4-23.

Add "*560K" below "R414 680K".

Add the following to the notes:

3. R414 IS *560K ON EQUIPMENTS BEGINNING WITH SERIAL NO. 496.

4. ON EQUIPMENTS BEGINNING WITH SERIAL NO. 601, REMOVE THE LEAD BETWEEN PIN 15 OF PLUG P401 AND THE JUNCTION OF R434 and C426, AND REMOVE THE GROUND FROM TERMINAL 1 OF TRANSFORMER T401. CONNECT A LEAD BETWEEN TERMINAL 1 OF TRANSFORMER T401 AND THE JUNCTION OF R434 AND C426.

Page 75. Fig. 43. Make the following changes in figure 43: Change "R421 1500", "R471 1K", "R422 1500", and "R505 1500" to read: 2200.

Change "R503 47K" to read: 15K.

Change "L506" to read: L506A, "L508" to read: L506B and delete the ground symbols from both.

Reverse the reference symbols of R458 and R474 but leave the values as they are.

Change the value of C502, C508, C509, and C517 from "25" to 4-23.

Change "+450" at pin 4 of P501 to read: +500.

Change "R414 680K" to read: 560K.

Change "R504", "3300" to read: 4700.

Delete pin 15 of plug P501 and the lead going to the junction of R434 and C426, and remove the ground from terminal 1 of transformer T401, connect a lead between terminal 1 of transformer T401 and the junction of R434 and C426.

Page 77. APP. II. Par. 2. Make the following changes in paragraph 2: Item 1. "Description" column. Line 3. Change "225 w dc" to read: 225 v dc and "200 w dc" to read: 200 v dc. In "Function of part" column, change 19Z to read: 19.

Item H450, H451, Description column. First sentence. Change "silver plarhodium" to read: silver pl and rhodium.

Item TB405, E406 change "E406" to read TB406.

Page 78. Item C401, C402. Description column. Change "±10%" to read: ±5%, and in function column, change "feedback" in C401 and C402 function to read: bypass.

Item C410. Function column. Change the function to read: Part of V403 plate load.

Item C412, *** C441. Description column. "+100%-0" to read: +100%-0%.

Page 79. Item C447, C448. Change "C448" in reference symbol and function columns to read: C449. Description column. Change "+100%-0" to read: +100%-0%.

Item C455. Description column. Change "8 uuf ±1%" to read: 8uuf ±1 uuf.

Item C456. Description column. Change "240 uuf" to read: 250 uuf. Change the stock No. to read: 3D9250-33.

Item C408 *** C461. Function column. Change the function to read: C415: Part of grid bias filter for V403 and V405.

Page 80. Item C403, C404. Description column. Second line. Change "850v a-c peak" to read: 600 v a-c peak.

Item C429, C409. Delete C409 in reference symbol and function columns. Change the function of C429 from "driver grid tuning" to read: DRIVER GRID TUNE.

Add "C437 and C439", as part of C429, in reference symbol column and add the following information in the function column:

C437: V410 grid tuning. C439: V409 grid tuning.

Item H497. Delete entire information for H497.

Item H440, H441. Add H559 in reference symbol column, and in description column, change, "ethyl cellulose acetate" to read: black saran plastic.

Item E421. Reference symbol column. Change "E421" to read: L412.

Page 81. Item L407. Function column. Change "l-c tuned" to read: L-c tuned.

Item L408, L411. Function column. Change the function of L411 to read: L411: V409 and V410 grid bias r-f choke.

Item Z401. Description column. Lines 3 and 4. Change ".263 in. dia approx." to read: .251 in. dia max.

Item P402. Reference symbol column. Add P403 after P402, and in description column, delete the information and substitute the following: CONNECTOR, plug: male, round; 31/32 in. lg x 27/64 in. dia; 52 ohms nom impedance.

Page 82. Item P401. Description column. Change the last line to read: 2-40 amp. 2 coaxial-10 amp.

Item H442. Delete the entire information for H442.

Item C440. Description column. Line 1. Change "MOUNTING" to read: PLATE, capacitor:

Page 83. Item HR401. Description column. Change the description to read: OVEN, crystal: 75° C min oven temp -40 to 75° C ambient temp, ±5° C; a-c 6.3 or 24 v, 60 cyc, single ph. 6.5 w; d-c 6.3 v or 24 v, 405 ma; aluminum case; 1-11/16 in. h x 1-1/4 in. dia.

Item A410. Description column. Change "±.101" to read: ±.010.

Item R401, R402, R462. Reference symbol and function columns. Delete the information for R401 and R402.

Item R403 * * * R474. Reference symbol and function columns. Delete the information for R403, R404, and change "R474" to read: R458 in the reference symbol and function columns.

Item R457. Reference symbol and function column. Delete the information for R457.

Page 84. Item R408, R412. Description column. Change "1/2 w" to read: 1/4 w, and change the stock No. to read: 3RC10BF103K.

Item R410. Description column. Change "10 ohms" to read: 15 ohms, and change the stock No. to read: 3RC30BF150K.

Item R417. Description column. Change "1/2 w" to read: 1/4 w, and change the stock No. to read: .3RC10BF472K.

Add the following after the information for R414:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R414 (on equipment with serial No. beginning with 496)	RESISTOR, fixed: comp; 560,000 ohms ±10%; 1/2 w.	V405 control grid bias.	3RC20BF564K
R457	RESISTOR, fixed: comp; 33,000 ohms, ±10%; 1/2 w.	V412 plate voltage dropping.	3RC20BF333K

Page 85. Item R440. Description column. Change "15,000" to read: 10,000, and "1 w" to 1/2 w, and change the stock No. to read: 3RC30BF103K.

Delete the information beginning with R454 through the end of the page and substitute the following:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R454, R401, R402	RESISTOR, fixed: comp; 15,000 ohms ±10%; 1/2 w.	R454: -22 volts voltage-dropping resistor at C459. R401 and R402: Parts of V401 and V402 input balance.	3RC20BF153K
R455, R461	RESISTOR, fixed: comp; 6,800 ohms ±10%; 1/2 w.	R455: -22 volts voltage-dropping resistor at C459. R461: -22 volts voltage-dropping resistor at C460.	3RC20BF682K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R456, R474, R403, R404	RESISTOR, fixed: comp; 470,000 ohms ±10%; 1/2 w.	R456: V413 control grid coupler. R474: V412 screen grid feedback limiter. R403: V403 suppressor grid bypass. R404: V404 suppressor grid bypass.	3RC20BF474K
R464	RESISTOR, fixed: comp; 2,200 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF222K
R465	RESISTOR, fixed: comp; 47 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF470K
R466	RESISTOR, fixed: comp; 100 ohms ±10%; 1/2 w.	V411 cathode voltage dropping resistor.	3RC20BF101K
R468, R469	RESISTOR, fixed: comp; 68,000 ohms ±10%; 1/2 w.	R468: V413 feedback control. R469: T401 secondary impedance balance shunt.	3RC20BF683K

Page 86. Item H435 * * * H478. Reference symbol column. Change "H478" to read: H479.

Item H488 thru H495. Description column. Change the description to read: RING, retainer: brass; .423 in. lg x .230 in. wd x .050 in. thk o/a.

Item H444. Description column. Change the description to read: BOLT, machine: steel; 8/32 thk; 5-1/2 in. nom lg.

Page 87. Item XCH425, XHR401, XV408. Reference symbol and description columns: Change "XHR401" to read: XE401.

Item H453. Function column. Line 1. Change "Mountain" to read: Maintains.

Page 88. Item E401 thru E403. Change "E401 thru E403" to read: E402, E403.

Page 89. App. II. Par. 3. Make the following changes for paragraph 3:

In the transmitter description column add: "Radio Transmitter T-416/GR" after "No. 201V1148."

Item C401, C402, C503. Reference symbol and function columns. Delete the information for C503 as part of C401 and C402, and insert it below C411 as part of that item.

Page 90. Item C455. Description column. Change "±1%" to read: ±1 uuf.

Page 91. Item C456. Description column. Change "240 uuf" to read: 250 uuf, and change the stock No. to read: 3D9250-33.

Item C408 *** C461. Function column. Change the function for "C415" to read: C415: Part of grid bias filter.

Item C403, C404, C508. Description column. Line 2. Change "850 v" to read: 600 v, and delete C508 from the reference symbol and function columns.

Page 92. Item Z401. Description column. Line 3. Change "263" to read: .251.

Page 93. Item P401. Description column. Line 3. Delete: "110 v ac".

Item P402, P403. Description column. Change the description to read: CONNECTOR, plug: 1 male, round cont; 31/32 in. lg x 27/64 in. dia; 52 ohms nom impedance.

Item HR501. Reference symbol column. Change "HR501" to read: E501, and change the description to read: OVEN, crystal: 1 xtal unit: 75°C min oven temp, -40 to 75° C ambient temp, ±5° C; ac, 6.3 v or 24 v, 60 cyc, single ph, 6.5

w; dc, 6.3 v or 24 v, 405 ma; 1-11/16 in. h x 1-1/4 in. dia.

Page 94. Item R406, R413, R457, R463. Reference symbol and description column. Delete R457.

Change the following items between K401 and R405 *** to read:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R403, R404, R462	RESISTOR, fixed: comp; 4,700 ohms ±10%; 1/2 w.	R403: V403 suppressor grid bypass. R404: V404 suppressor grid bypass. R462: V411 plate voltage dropping.	3RC20BF473K
R411, R418, R423, R451, R458	RESISTOR, fixed: comp; 100,000 ohms ±10%; 1/2 w.	R411: V404 screen grid voltage dropping. R418: V406 control grid bleeder. R423: V407 control grid bleeder. R451: V413 screen and control grid voltage dropping. R458: V411 screen dropping.	3RC20BF104K
R457	RESISTOR, fixed: comp; 33,000 ohms ±10%; 1/2 w.	V412 voltage dropping.	3RC20BF333K

Page 95. Item R410. Description column. Change "10 ohms" to read: 15 ohms, and change the stock No. to read: 3RC30BF150K.

Item R414. Description column. Change "680,000 ohms ±10%" to read: 560,000 ohms ±5%, and change the stock No. to read: 3RC20BF560J.

Change the items between item R417 and R432, R433 to read:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R426, R427, R430, R431	RESISTOR, fixed: comp; 1500 ohms ±10%; 2 w.	R426, R427: V407 screen grid bias voltage dropping. R430, R431: V406 and V407 screen grid bias voltage dropping.	3RC42BF152K
R421, R422, R428, R429, R505	RESISTOR, fixed: comp; 2200 ohms ±10%; 2 w.	R421, R422: V406 screen grid voltage dropping. R428, R429: V406 and V407 screen grid voltage dropping. R505: V502 screen grid voltage dropping.	3RC42BF222K

Change the items between items R450, R459, R467 and R455, R461 to read:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R401, R402, R510	RESISTOR, fixed: comp; 15,000 ohms ±10%; 1/2 w.	R401, R402: Part of V401 and V402 input balance. R510: Minus 22-volt bias dropping.	3RC20BF153K
R456, R474, R502	RESISTOR, fixed: comp; 470,000 ohms ±10%; 1/2 w.	R456: V413 control grid coupler. R474: V412 screen grid voltage dropping. R502: Metering jack J501 voltage dropping.	

Page 96. Change the items at the beginning of the page item R471, R472 to read:

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R464	RESISTOR, fixed: comp; 2200 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF222K
R466	RESISTOR, fixed: comp; 100 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF101K
R465	RESISTOR, fixed: comp; 47 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF470K
R468, R469	RESISTOR, fixed: comp; 68,000 ohms ±10%; 1/2 w.	R468: V413 feedback control. R469: T401 secondary impedance balance shunt.	3RC20BE683K
R471	RESISTOR, fixed: comp; 2200 ohms ±10%; 2 w.	V406 screen grid voltage dropping.	3RC42BF222K
R472	RESISTOR, fixed: comp; 1000 ohms ±10%; 2 w.	V407 screen grid voltage dropping.	3RC42BF102K

Item R501. Description column. Change 22,00 ohms'' to read: 22,000 ohms.

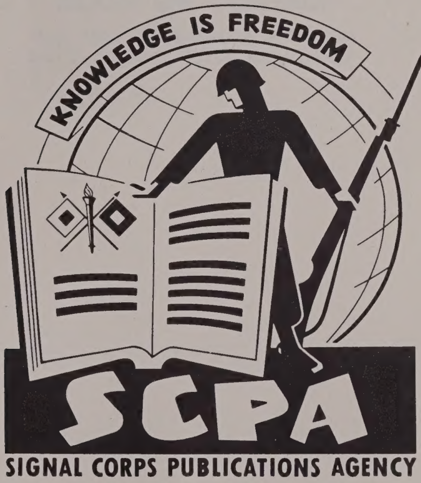
Item R503. Description column. Change ''47,000 ohms'' to read: 15,000 ohms, and change the stock No. to read: 3RC30BF153K.

Item R504. Description column. Change ''3300 ohms'' to read: 4700 ohms, and change the stock No. to read: 3RC30BF472K.

Item H488 thru H495: Description column. Change the description to read: RING, retainer: brass; .423 in. lg x .230 in. wd x .050 in. thk o/a.

Page 97. Item XC425, XHR401, XV408. Reference symbol and description columns. Change ''XHR401'' to read: XE401.

INSTRUCTION BOOK
for
RADIO TRANSMITTER T-278/U
and
RADIO TRANSMITTER T-416/GR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10 MARCH 1953

WARNING

HIGH VOLTAGE

is used in the operation of
this equipment

DEATH ON CONTACT

may result if operating personnel
fail to observe safety precautions.

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ARTIFICIAL RESPIRATION

GENERAL PRINCIPLES

1. Seconds count! Begin at once! Don't take time to move the victim unless you must. Don't loosen clothes, apply stimulants or try to warm the victim. Start resuscitation! Get air in the lungs! You may save a life!

2. Place the victim's body in a prone position, so that any fluids will drain from the respiratory passages. The head should be extended and turned sideward *never flexed forward;* the chin shouldn't sag, since obstruction of the respiratory passages may occur.

3. Remove any froth or debris from the mouth with your fingers. Draw the victim's tongue forward.

4. Begin artificial respiration. Continue it rhythmically and without any interruption until natural breathing starts or the victim is pronounced dead. Try to keep the rhythm smooth. Split-second timing is not absolutely essential.

5. When the victim starts breathing, or when additional help is available loosen the clothing; remove it, if it's wet; keep the victim warm. Shock should receive adequate attention. Don't interrupt the rhythmical artificial technique for these measures. Do them only when you have help or when natural breathing has started.

6. When the victim is breathing, adjust your timing to assist him. Don't fight his efforts to breathe. Synchronize your efforts with his. After resuscitation, keep him lying down until seen by a physician or until recovery seems certain.

7. Don't wait for mechanical resuscitation! If an approved model is available, use it, but, since mechanical resuscitators are only slightly more effective than properly performed "push-pull" manual technique, *never* delay manual resuscitation for it.

BACK-PRESSURE ARM LIFT METHOD

1. *Position of Victim.* Place the victim in the prone (face-down) position. Bend his elbows; place one hand upon the other. Turn his face to one side, placing his cheek upon his hands.

2. *Position of Operator.* Kneel on your left or right knee, at the victim's head, facing him. Your knee should be at the side of the victim's head close to his forearm, your foot should be near his elbow. Kneel on both knees if you find it more comfortable, with one knee on each side of the head. Place your hands on the flat of the victim's back so that their heels are just below the lower tip of his shoulder blades. With the tip of your thumbs touching spread your fingers downward and outward. (See A)

3. *Compression Phase.* Rock forward until your arms are approximately vertical and allow the weight of the upper part of your body to exert a slow, steady, even, downward pressure upon your hands. This forces air out of the lungs. Keep your elbows straight and press almost directly downward on the back. (See B)

4. *Expansion Phase.* Release the pressure, avoid any finish thrust, and commence to rock backward slowly. Place your arms upon the victim's arms just above the elbows, and draw his arms upward and toward you. Apply just enough lift to feel resistance and tension at the victim's shoulders.

Don't bend your elbows. As you rock backward, the victim's arms will be drawn toward you. (The arm lift expands the chest by pulling on the chest muscles, arching the back and relieving the weight on the chest.) Drop the arms gently to the ground or floor. This completes the cycle. (See C and D). Now, repeat the cycle.

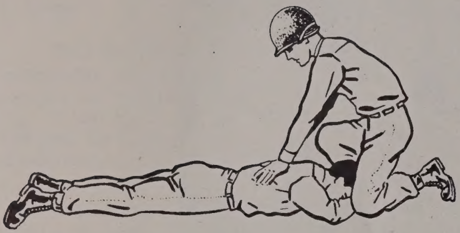
5. *Cycle Timing and Rhythm.* Repeat the cycle 10 to 12 times per minute. Use a steady uniform rate of Press, Release, Lift, Release. Longer counts of about equal length should be given to the "Press" and "Lift" steps of the compression and expansion phases. Make the "Release" periods of minimum duration.

6. *Changing Position or Operator.*

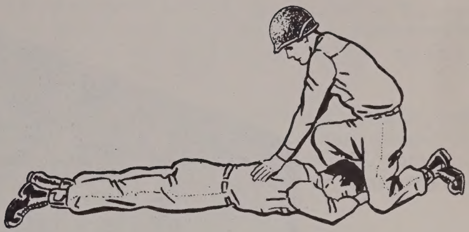
(*a*) Remember that you can use either or both knees or can shift knees during the procedure, provided you don't break the rhythm. Observe how you rock forward with the back-pressure and backward with the arm-lift. The rocking motion helps to sustain the rhythm and adds to the ease of operation.

(*b*) If you tire and another person is available, you can "take turns." Be careful not to break the rhythm in changing. Move to one side and let your replacement come in from the other side. Your replacement begins the "Press-Release" after one of the "Lift-Release" phases, as you move away.

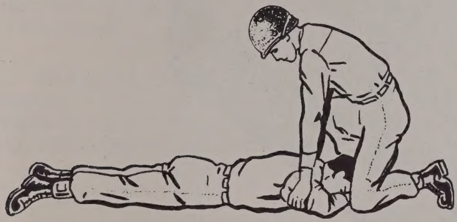
TM AR-3



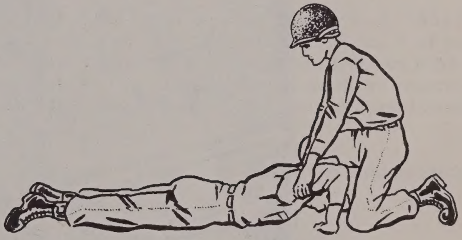
A Position of operator and victim



B Compression phase



C Expansion phase (arm lift)



D Expansion phase (arm release)

TM AR-4

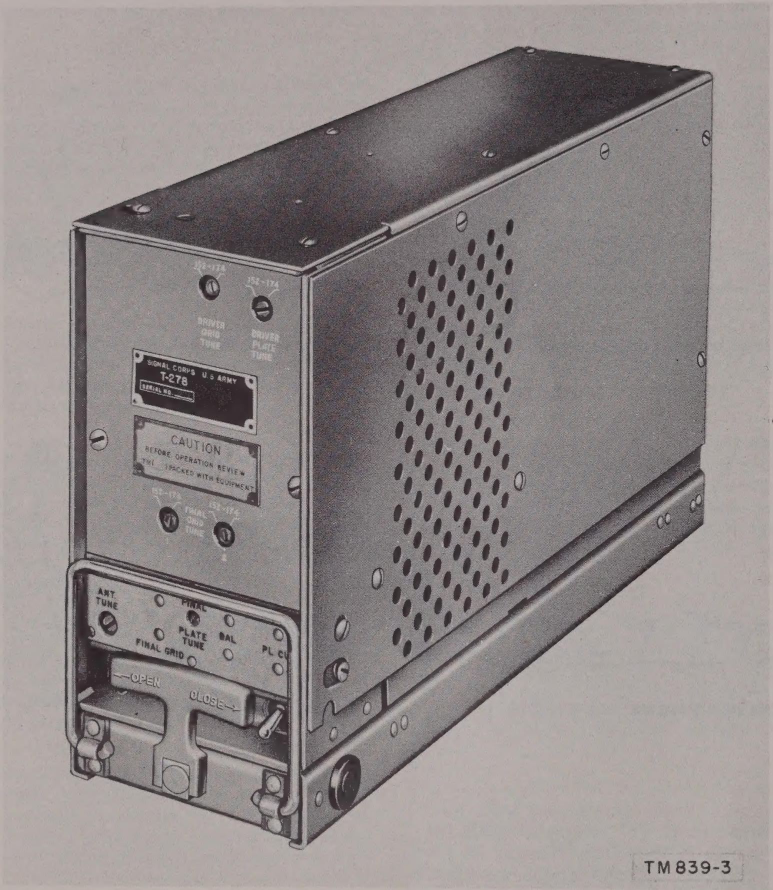

152-174
152-174
DRIVER GRID TUNE
DRIVER PLATE TUNE
SIGNAL CORPS U.S. ARMY
T-278
SERIAL NO.
CAUTION
BEFORE OPERATION REVIEW
TM PACKED WITH EQUIPMENT
152-174
FINAL GRID TUNE
152-174
1
2
ANT. TUNE
FINAL
PLATE TUNE
BAL
PL CU
FINAL GRID
OPEN
CLOSE
TM839-3

Figure 1. Radio Transmitter T-278/U.

Note. This instruction book will be replaced by TM 11-839 which, when published, will be listed in SR 310-20-4.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This instruction book contains the necessary information for the installation, operation, maintenance and repair of Radio Transmitter T-278/U (fig. 1) and Radio Transmitter T-416/GR. In addition, there are two appendixes covering a list of references, and an identification table of parts.

b. Transmitter operation is developed on the basis of Radio Transmitter T-278/U as used in the mobile system of Radio Set AN/VRC-19(*).

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army), NAV DEPT SERIAL 85P00 (Navy), and AFR 71-4 (Air Force).

b. DA AGO Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700-45-5.

c. USAF Form 54, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AFR 65-26.

d. DA AGO Form 11-238, Operator First Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 11).

e. DA AGO Form 11-239, Second and Third Echelon Maintenance Checklist for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar), will be prepared in accordance with instructions on the back of the form (fig. 12).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Radio Transmitter T-278/U is an f-m (frequency-modulated) radio transmitter designed for mobile use. Radio Transmitter T-416/GR operates from a fixed station. Both transmitters are intended for use in a system application, to provide point-to-point, two-way communication or radio-relay service by retransmission.

b. Both transmitters cover a frequency range of 152 to 174 mc (megacycles), with a nominal power output of 30 watts for Radio Transmitter T-278/U and 50 watts for Radio Transmitter T-416/GR. Provision is made for dual frequency operation by the selection of either of two preset crystal-controlled frequencies.

c. The transmitters are not self-contained, but must be used in conjunction with a system. They are supplied with sufficient running spares from the system spares. Operating equipment for field use also is supplied.

4. System Application
(fig. 2)

a. Radio Transmitter T-278/U Used with Radio Set AN/VRC-19(*).

(1) This application provides ordinary single-channel, simplex voice communication between two points. Simplex operation means two-way communication between two points, but only in one direction at a time. Only one antenna system is required.

(2) The use of separate antennas for the transmitter and the receiver provides radio-relay facilities. Signals picked up by

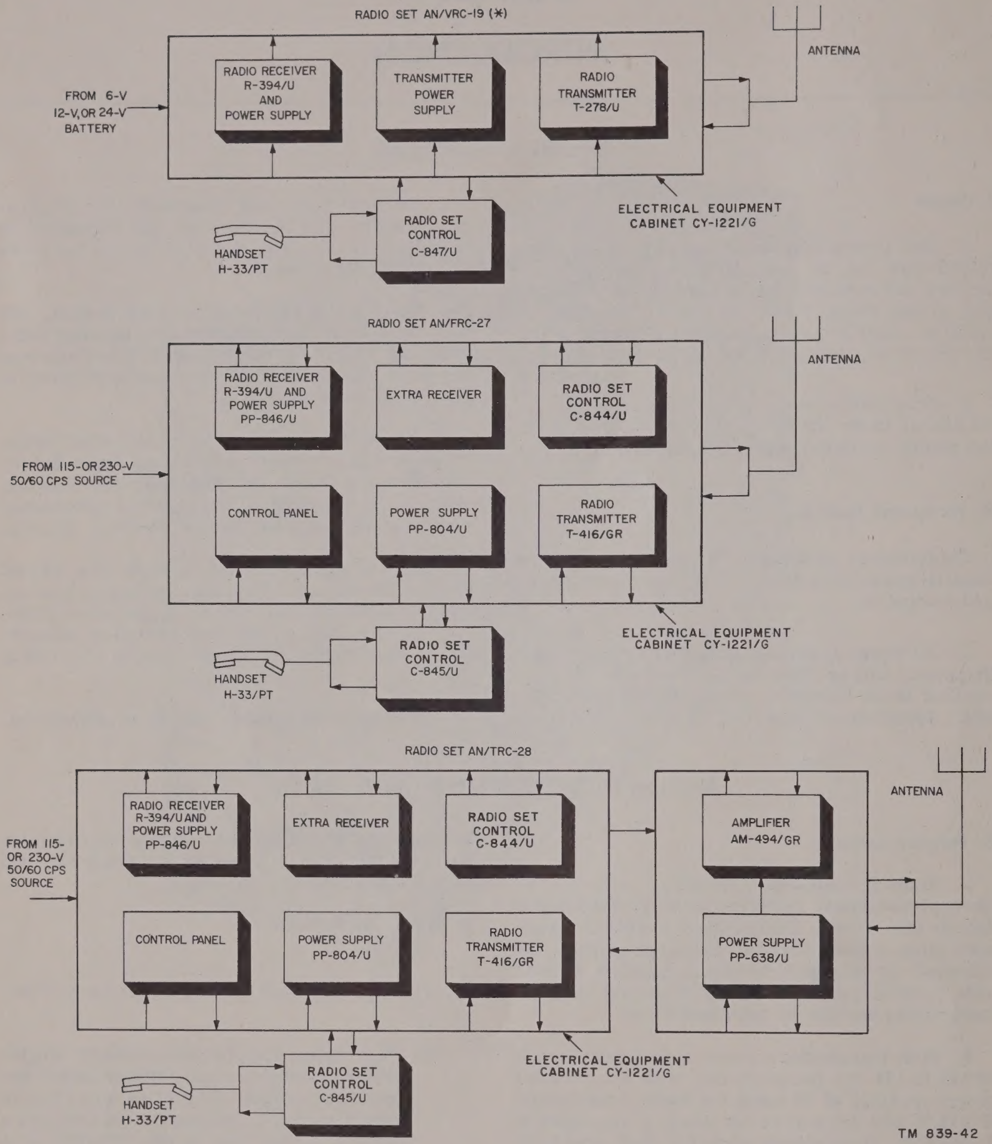

RADIO SET AN/VRC-19 (*)
ANTENNA
FROM 6-V 12-V, OR 24-V BATTERY
RADIO RECEIVER R-394/U AND POWER SUPPLY
TRANSMITTER POWER SUPPLY
RADIO TRANSMITTER T-278/U
ELECTRICAL EQUIPMENT CABINET CY-1221/G
HANDSET H-33/PT
RADIO SET CONTROL C-847/U
RADIO SET AN/FRC-27
ANTENNA
FROM 115-OR 230-V 50/60 CPS SOURCE
RADIO RECEIVER R-394/U AND POWER SUPPLY PP-846/U
EXTRA RECEIVER
RADIO SET CONTROL C-844/U
CONTROL PANEL
POWER SUPPLY PP-804/U
RADIO TRANSMITTER T-416/GR
ELECTRICAL EQUIPMENT CABINET CY-1221/G
HANDSET H-33/PT
RADIO SET CONTROL C-845/U
RADIO SET AN/TRC-28
ANTENNA
FROM 115- OR 230-V 50/60 CPS SOURCE
RADIO RECEIVER R-394/U AND POWER SUPPLY PP-846/U
EXTRA RECEIVER
RADIO SET CONTROL C-844/U
CONTROL PANEL
POWER SUPPLY PP-804/U
RADIO TRANSMITTER T-416/GR
AMPLIFIER AM-494/GR
POWER SUPPLY PP-638/U
ELECTRICAL EQUIPMENT CABINET CY-1221/G
HANDSET H-33/PT
RADIO SET CONTROL C-845/U
TM 839-42

Figure 2. Radio Sets AN/VRC-19(*), AN/FRC-27, and AN/TRC-28, block diagrams.

the radio receiver at one frequency serve to modulate the transmitter, which will retransmit the signal on another frequency.

(3) The transmitter is housed in Electrical Equipment Cabinet CY-938/VRC, together with a transmitter power supply and the complete Radio Receiver R-394/U. Any one of three power supplies may be used. Each power supply is intended for mobile operation, and receives its input power from a 6-, 12-, or 24-volt battery. Radio Set Control C-847/U is used to control both the receiver and transmitter. Push-to-talk operation is provided by Handset H-33/PT. The power output of this system is 30 watts.

b. Radio Transmitter T-416/GR Used with Radio Set AN/FRC-27.

(1) This application provides single-channel simplex voice communication, with either local or remote control. Radio-relay operation by retransmission is possible by providing a separate antenna for the radio receiver. The system is designed for fixed station operation.

(2) The use of an additional radio receiver provides single-channel duplex communication between two points. This arrangement uses two operating frequencies. Normally, it provides one voice channel in each direction. The communication can take place in both directions simultaneously, enabling the operators to talk to each other as in normal conversation.

(3) The transmitter is housed in Case CY-1221/U, together with a transmitter power supply, two complete radio receivers, and a local control unit. A remote control unit is connected externally. Push-to-talk operation is provided by the handset. The power output of the system is 50 watts.

c. Radio Transmitter T-416/GR Used with Radio Set AN/TRC-28.

(1) This application is for fixed station operation and provides both simplex and duplex, single-channel voice communication with either local or remote control. Radio-relay service by retransmission is also possible.

(2) The transmitter is housed in Case CY-1221/U together with a transmitter power supply, two complete radio receivers, and a local control unit. A remote control unit is connected externally. With this system, an r-f (radio-frequency) power amplifier and its power supply are included to increase the transmitter power output to 250 watts.

5. Technical Characteristics

a. Radio Transmitters T-278/U and T-416/GR.

Frequency range.	152 to 174 mc.
Transmitter type	Crystal-controlled f-m.
Distance range	Line of sight.
Type of modulation	F-m, as derived from phase modulation.
Frequency deviation . . .	15 kc (kilocycles) for 100% modulation at 1,000 cycles. Deviation limited to 15 kc for all frequencies.
Type of transmission. . .	Voice.
Crystals:	
Type	Crystal Unit CR-27/U, calibrated for 32-uuf (micromicrofarad) circuit.
Frequency range	4,750 to 5437.5 kc.
Multiplication in transmitter	32 times on all frequencies.
Dual frequency operation.	Maximum of 500 kc between operating frequencies.
Output impedance	50 ohms into coaxial cable.
Audio input:	
Carbon microphone. . .	100 mv (millivolt) for 100% modulation at 1,000 cycles.
600-ohm line input . . .	200 mv for 100% modulation at 1,000 cycles.
Spurious emission.	Attenuated at least 70 db (decibels) below carrier.
Antenna.	1/4 wavelength vertical.
Weight, unmounted	8-3/4 lb.

b. Radio Transmitter T-278/U.

Number of tubes	13.
Power supply	External d-c (direct-current) operated Power Supply PP-640/U, PP-639/U, or Dynamotor DY-98/U.
Power output	30 watts.

c. Radio Transmitter T-416/GR.

Number of tubes	12.
Power supply	External a-c (alternating-current) operated Power Supply PP-804/U.
Power output	50 watts.

6. Packaging Data

Radio Transmitters T-278/U and T-416/GR are mounted in either Electrical Equipment Cabinet CY-938/VRC or Case CY-1221/U, depending upon system application (par. 4). When packaged for export shipment, the case is placed in a moisture-vaporproof container and is packed in a wooden export crate. For specific packaging instructions refer to the appropriate system technical manual.

7. Description of Radio Transmitters T-278/U and T-416/GR

a. The transmitter is designed as a plug-in unit, to function as a component of a system and is mounted in a weatherproof case together with system equipment. All connections to the transmitter are made through a single connector mounted in the case. It is not self-contained, but is dependent upon system equipment for power and control.

b. The front panel of the transmitter provides controls for tuning, and test point jacks to provide a means for visual indication (a meter) during the tuning procedure. Over-all dimensions of the transmitter are 8-1/8 inches high, 4-1/4 inches wide, and 13-1/4 inches deep.

8. Running Spares

A group of running spares is supplied with each system. Spares are provided for all normally expendable items such as tubes, fuses, pilot lamps, and vibrators. Running spares of Radio Set AN/VRC-19(*) provide at least one of the following tubes for use in Radio Transmitter T-278/U:

Tube, type 1AD4.
Tube, type 5678.
Tube, type 5672.
Tube, type 3B4.
Tube, type 2E24.

9. Additional Equipment Required

Radio Transmitters T-278/U and T-416/GR, are provided with additional equipment when installed for system operation. All system components are required, because of the multiple interconnections between units. The block diagram of figure 2 shows the additional equipment required for each system.

10. Differences in Models

a. The external appearance of Radio Transmitters T-278/U and T-416/GR differ only in the placement of controls on the front panel (figs. 5 and 6). The function and operation of each control remains the same.

b. The exciter chassis of Radio Transmitter T-278/U is also used in Radio Transmitter T-416/GR. This includes all stages employing tubes V401 through V407, and V411 through V413. To provide a power output of 50 watts, Radio Transmitter T-416/GR employs higher power tubes. These are tube V501, a type 2E26, operating as the fifth doubler and driver, and tube V502, a type 5894A, operating as a push-pull amplifier.

c. Higher plate, screen, and bias voltages are used and circuit components change correspondingly to provide correct operating characteristics for the changed circuit. All reference symbols in the fifth doubler and driver stage and the power-amplifier stage are designated in the 500 series. The reference symbol for the plug-in connector on the back of the transmitter is changed to plug P501. Refer to paragraphs 46e, 47b, and 48b for a detailed description of circuit changes, and to figure 43 for the schematic diagram of Radio Transmitter T-416/GR.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

11. Siting

a. Radio Transmitter T-278/U is mounted in Electrical Equipment Cabinet CY-938/VRC for use in the mobile system of Radio Set AN/VRC-19(*).

b. Radio Transmitter T-416/GR is mounted in Case CY-1221/U for use in the fixed station system of Radio Set AN/FRC-27 or Radio Set AN/TRC-28.

12. Uncrating, Unpacking, and Checking New Equipment

a. Remove all the packing material from the case containing the transmitter.

b. Release the latches on the top of the case and then remove the cover.

c. Release the transmitter from the case by turning the hold-in lock counterclockwise (fig. 30). This action will move the transmitter slightly out of the case and should be continued until further turning produces no further movement. The transmitter then may be pulled out of the case by use of the handle located on the front panel.

d. Inspect the pins on the plug, located behind the transmitter (fig. 3), to be certain that none have been bent or damaged in shipment.

e. Remove the right and left side dust covers from the transmitter to check for damaged tubes, resistors, broken leads, bent parts, etc. Check to see that all tubes are seated firmly in their proper sockets (fig. 4).

13. Installation and Connections

Caution: Fuses are installed in order to protect the equipment from an overload. Do not use fuses rated higher than the specified values when replacing them in the equipment.

a. After checking the transmitter, remount the dust covers and slide the transmitter onto the guide rails in the case.

b. Push back firmly, without forcing or bumping the transmitter against the back of the case.

c. Turn the hold-in lock clockwise until the transmitter is seated securely in place. This

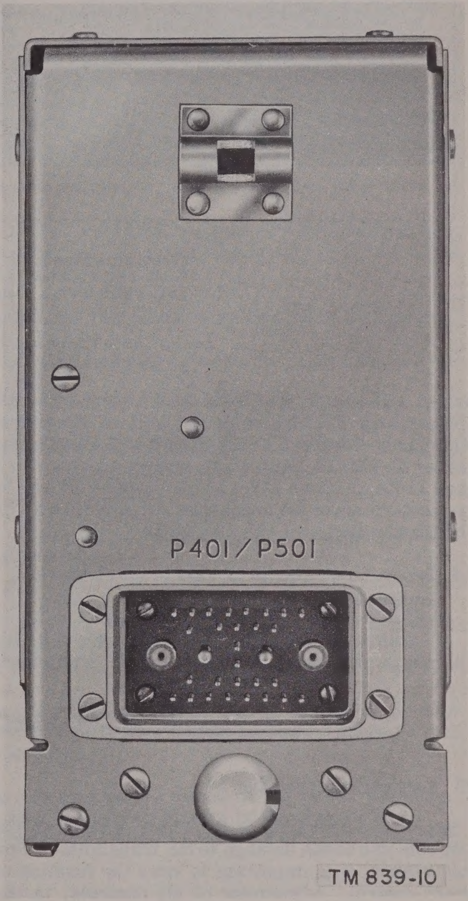
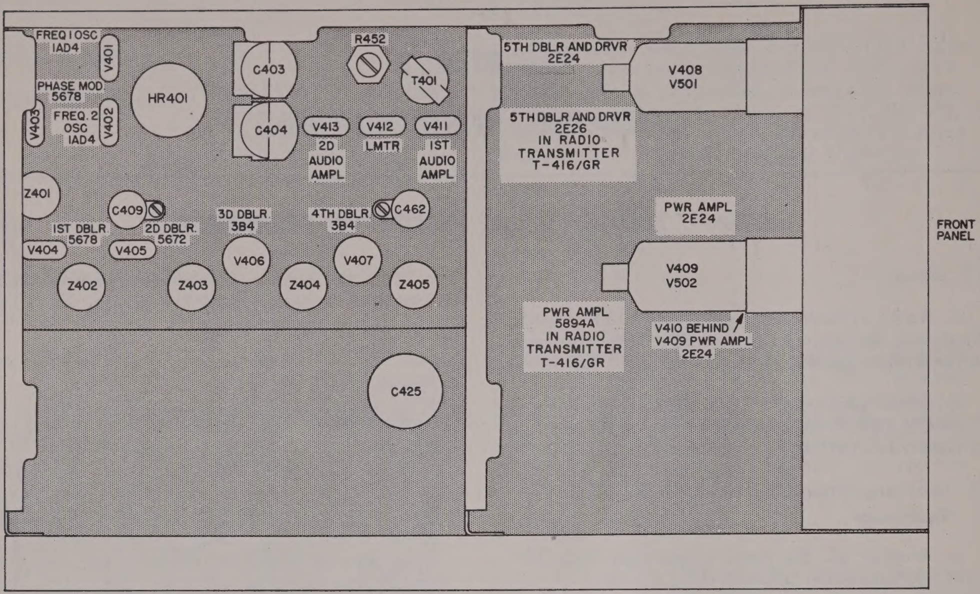


Figure 3. Radio Transmitters T-278/U and T-416/GR, rear view.


FREQ I OSC
IAD4
V401
PHASE MOD
5678
FREQ. 2
OSC
IAD4
V403
V402
HR401
C403
C404
R452
T401
V413
2D
AUDIO
AMPL
V412
LMTR
V411
IST
AUDIO
AMPL
Z401
C409
IST DBLR
5678
2D DBLR.
5672
V404
V405
3D DBLR
3B4
4TH DBLR
3B4
C462
V406
V407
Z402
Z403
Z404
Z405
C425
5TH DBLR AND DRVR
2E24
V408
V501
5TH DBLR AND DRVR
2E26
IN RADIO
TRANSMITTER
T-416/GR
PWR AMPL
2E24
V409
V502
PWR AMPL
5894A
IN RADIO
TRANSMITTER
T-416/GR
V410 BEHIND
V409 PWR AMPL
2E24
FRONT
PANEL

NOTE:
REFERENCE NUMBERS OF 500
SERIES ARE LOCATED IN
RADIO TRANSMITTER T-416/GR

TM 839-33

Figure 4. Radio Transmitters T-278/U and T-416/GR, tube locations.

action will engage plug P401 on the back of Radio Transmitter T-278/U to jack J801 of Electrical Equipment Cabinet CY-938/VRC. In Radio Transmitter T-416/GR, plug P501 makes contact with jack J1904 of Case CY-1221/U. These plug-in connectors make all necessary connections to the transmitter.

14. Service Upon Receipt of Used or Reconditioned Equipment

a. Follow the instructions in paragraph 12 for uncrating, unpacking, and checking the equipment.

b. Check the used or reconditioned equipment for tags or other indications pertaining to changes in wiring of the equipment. If any changes have been made, note the changes in this instruction book, preferably on the schematic diagrams. If no tags are found, make the operational test described in paragraph 62 to ascertain that the equipment is functioning properly.

c. Perform the installation and connection procedures outlined in paragraph 13.

Section II. CONTROLS AND INSTRUMENTS

15. Controls and Their Use

Haphazard operation or improper setting of the controls can cause damage to the transmitter. For this reason, it is important to know the function of every control. Adjustment of all controls, in the proper order, is discussed in paragraphs 18 and 19.

16. Radio Transmitters T-278/U and T-416/GR Front Panel Controls

(figs. 5 and 6)

The following chart lists the transmitter controls and indicates their functions. Numbers in the 500 series, shown in the control column, indicate the nomenclature of the equivalent control in Radio Transmitter T-416/GR.

Control	Function
TEST-OFF switch (S402) (S501)	In the TEST position, energizes a relay in an external power supply to provide power for the transmitter. In the OFF position local power is removed and is applied to the transmitter when the push-to-talk switch of Handset H-33/PT is depressed.
TUNE-OPR switch (S401) (S502)	In the TUNE position, the switch reduces screen voltage applied to the driver and the power-amplifier tubes. In the OPR position, it allows normal screen voltage.
DRIVER GRID TUNE control (C429) (C502)	Tunes the driver grid tank circuit to resonate with the signal from the fourth doubler stage.
DRIVER PLATE TUNE control (C436) (C507)	Tunes the fifth doubler and driver plate tank circuit to resonance at thirty-two times the crystal frequency.
FINAL GRID TUNE 1 control (C439) (C509)	Tunes the grid tank circuit of power-amplifier tube V409 to resonance. In Radio Transmitter T-416/GR the control tunes the grid tank circuit of one-half of power-amplifier tube V502 to resonance.
FINAL GRID TUNE 2 control (C437) (C508)	Tunes the grid tank circuit of power-amplifier tube V410 to resonance. In Radio Transmitter T-416/GR the control tunes the grid tank circuit of the other half of power-amplifier tube V502 to resonance.
FINAL PLATE TUNE control	Fine tuning control for the power-amplifier plate tank circuit.
COUPLING-MAX-MIN control (L412) (L507)	Provides MIN or MAX coupling between the plate lines and the output link.
ANT. TUNE control (C451) (C517)	Acts as the antenna loading adjustment.
DRIVER GRID jack (J405) (J501)	Test point for checking grid voltage during tuning of the fifth doubler and driver stage.
FINAL GRID jack (J406) (J502)	Test point for checking grid voltage of the power amplifier during tuning procedure.
BAL jacks (J407 and J408) (J503 and J504)	Test points for checking the balance (equality) of plate current at the output of the push-pull power-amplifier stage during the tuning procedure.
PL CUR jacks (J409 and J410) (J505 and J506)	Test points for checking plate current of the power-amplifier stage when tuning for proper loading of the transmitter.

17. Radio Set Control C-847/U Controls
(fig. 7)

Radio Set Control C-847/U is necessary for the operation of Radio Transmitter T-278/U with Radio Set AN/VRC-19(*). Control functions are listed in the following table.

Control	Function
VOLUME-OFF (S1501) switch	This switch turns on the power to the radio set. It also adjusts the volume level of the handset, earphone, and speaker by the insertion of an attenuator pad. Four volume levels are available.
SPKR ON-OFF (S1502) switch	This switch connects the speaker in the ON position. In the OFF position, the speaker is disconnected and is replaced by a 10-ohm resistor. The switch is spring loaded to remain in the ON position.
POWER indicator (I 1501)	This pilot lamp glows whenever the VOLUME switch is in any position but OFF. It indicates that power is applied to the receiver.
TRANSMIT indicator (I 1502)	This pilot lamp glows when the push-to-talk switch on the handset is closed indicating the transmitter is in operation and the receiver is disabled.
SQUELCH-OFF control (R1509) and switch (S1504)	The receiver squelch circuit is disabled with the SQUELCH control in the OFF position. In other positions the control sets the threshold of squelch operation.
FREQ switch (S1503)	The FREQ switch selects either of two fixed transmitter frequencies. The selection is made by supplying only one oscillator filament with power at a time.
Handset connector (J1501)	This connector is located on the bottom of the control. It provides a connection from the handset to the receiver and transmitter.
Speaker	The speaker is provided to enable the operator to hear the incoming signals without having to continually hold the handset. This feature is especially helpful for squelch operation while the vehicle is in motion or when more than one person desires to listen.

Section III. PRELIMINARY ADJUSTMENTS AND TUNING

18. Preliminary Adjustment of Radio Transmitter T-278/U

Before the transmitter can be tuned to the operating frequency, the following preliminary steps should be taken.

a. Release the transmitter from Electrical Equipment Cabinet CY-938/VRC by turning the hold-in lock counterclockwise. The transmitter then may be pulled out of the case by use of the handle located on the front panel.

b. Remove the right and left side dust covers from transmitter and check to see that all tubes are seated solidly and in place (fig. 4).

c. A patch cord is required to complete system connections when the transmitter is removed from Electrical Equipment Cabinet CY-938/VRC. This cord is described in paragraph 30. Connect the patch cord from jack J801 in the case to plug P401 on rear of the transmitter.

d. Connect the transmitting antenna to antenna plug P801 on the case.

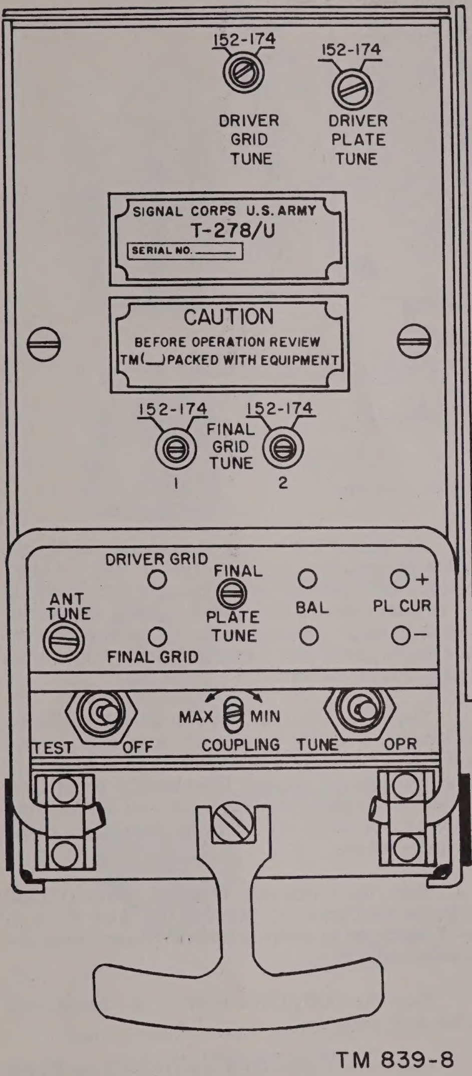

152-174
152-174
DRIVER GRID TUNE
DRIVER PLATE TUNE
SIGNAL CORPS U.S. ARMY
T-278/U
SERIAL NO.
CAUTION
BEFORE OPERATION REVIEW
TM(__)PACKED WITH EQUIPMENT
152-174
152-174
FINAL GRID TUNE
1
2
DRIVER GRID
FINAL PLATE TUNE
ANT TUNE
FINAL GRID
BAL
PL CUR
+
−
MAX
MIN
COUPLING
TEST
OFF
TUNE
OPR
TM 839-8

Figure 5. Radio Transmitter T-278/U, front panel.

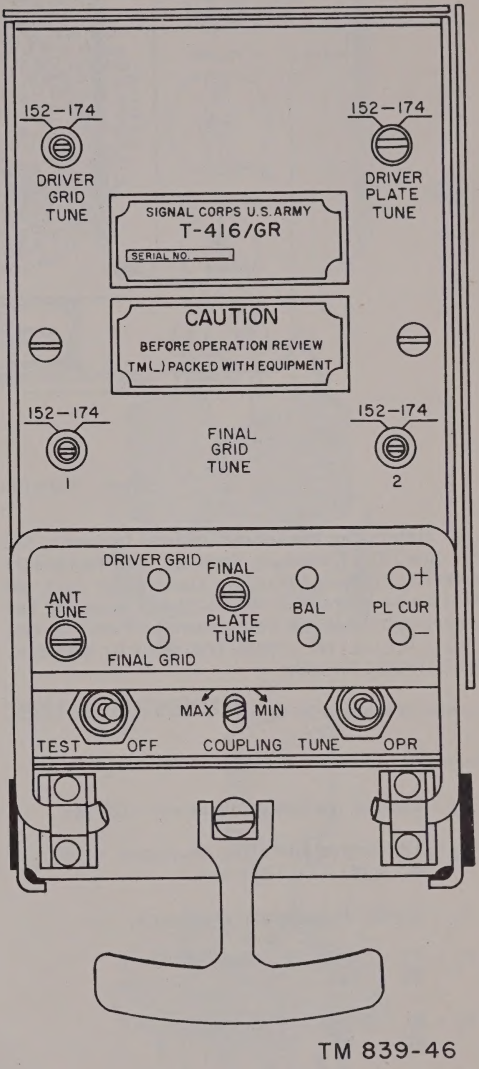

152-174
152-174
DRIVER GRID TUNE
DRIVER PLATE TUNE
SIGNAL CORPS U.S. ARMY
T-416/GR
SERIAL NO.
CAUTION
BEFORE OPERATION REVIEW
TM(_) PACKED WITH EQUIPMENT
152-174
152-174
FINAL GRID TUNE
1
2
DRIVER GRID
FINAL PLATE TUNE
ANT TUNE
FINAL GRID
BAL
PL CUR
+
−
MAX
MIN
COUPLING
TEST
OFF
TUNE
OPR
TM 839-46

Figure 6. Radio Transmitter T-416/GR, front panel.

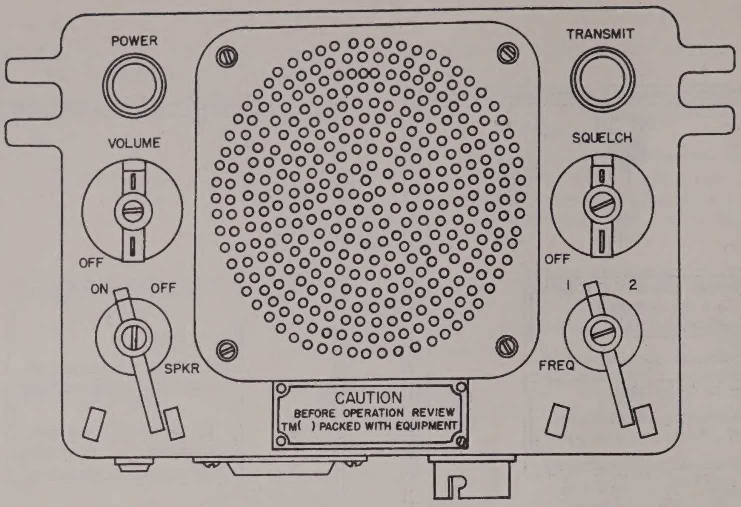


Figure 7. Radio Set Control C-847/U, front panel.

e. Determine the correct crystal frequency for the operating frequency desired. The two preset operating frequencies of the transmitter may not differ by more than 500 kc. After selecting two operating frequencies which meet this requirement, choose the correct crystal frequency by means of the following formula:

$$\text{crystal frequency in kc} = \frac{\text{operating frequency in kc}}{32}.$$

Example:

F_1 = desired operating frequency = 162 mc.

F_2 = alternative operating frequency = $162 \pm .5$ mc = 161.5 or 162.5 mc.

F_c = crystal fundamental frequency.

$$F_c = \frac{F1}{32} = \frac{162000}{32} \text{ kc} = 5062.500\text{-kc}.$$

$$F_c = \frac{F2}{32} = \frac{161500}{32} = 5046.875\text{-kc}.$$

To maintain accuracy of the operating frequency, carry division out to three places to the right of the decimal point. This example uses the maximum allowable frequency difference between the two operating frequencies. Actually, more efficient transmitter operation is attained when the two frequencies chosen are closer together. (See par. 22.)

f. To install the required crystals, unplug the entire crystal oven assembly HR401 (figs. 8 and 9). Remove the three screws that secure the cover of the crystal oven to the socket, unplug the heater and thermostat element from the socket; then insert the crystals into the socket base. Reassemble in the reverse order.

g. Turn the VOLUME-OFF switch on Radio Set Control C-847/U clockwise to apply power to the heating element of the crystal oven. At least 15 minutes heating time should be allowed before performing the step outlined in subparagraph 19b below in order to attain a stable crystal temperature.

h. Turn the frequency selector switch (FREQ) on Radio Set Control C-847/U to either the 1 or the 2 position to apply filament power to the desired oscillator.

i. Turn the COUPLING control on transmitter to the MIN position.

j. Place the TUNE-OPR switch in the TUNE position.

19. Tuning Radio Transmitters T-278/U and T-416/GR

To tune the transmitter, two meters are required. One is a VTVM (vacuum-tube voltmeter) Electronic Multimeter TS-505/U or equal, for measuring grid voltage, and the other is a voltmeter with a

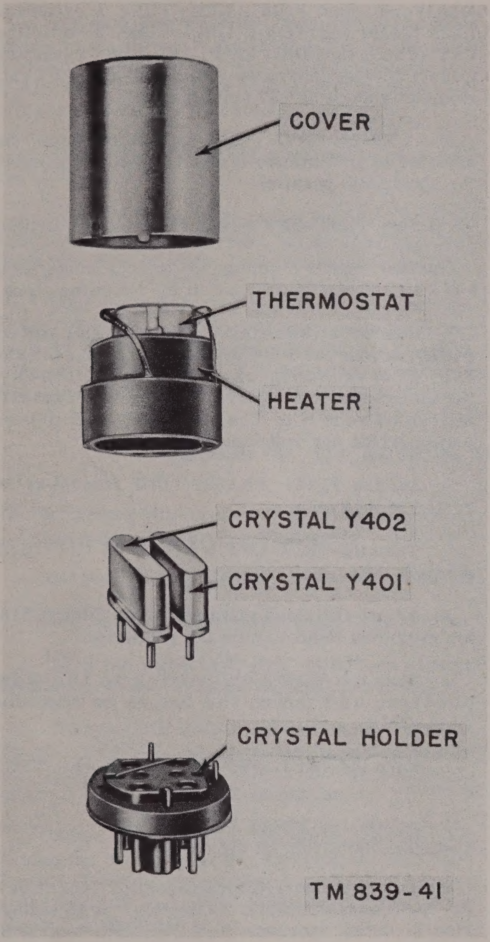

COVER
THERMOSTAT
HEATER
CRYSTAL Y402
CRYSTAL Y401
CRYSTAL HOLDER
TM 839-41

Figure 8. Radio Transmitters T-278/U and T-416/GR crystal oven HR401, disassembled view.

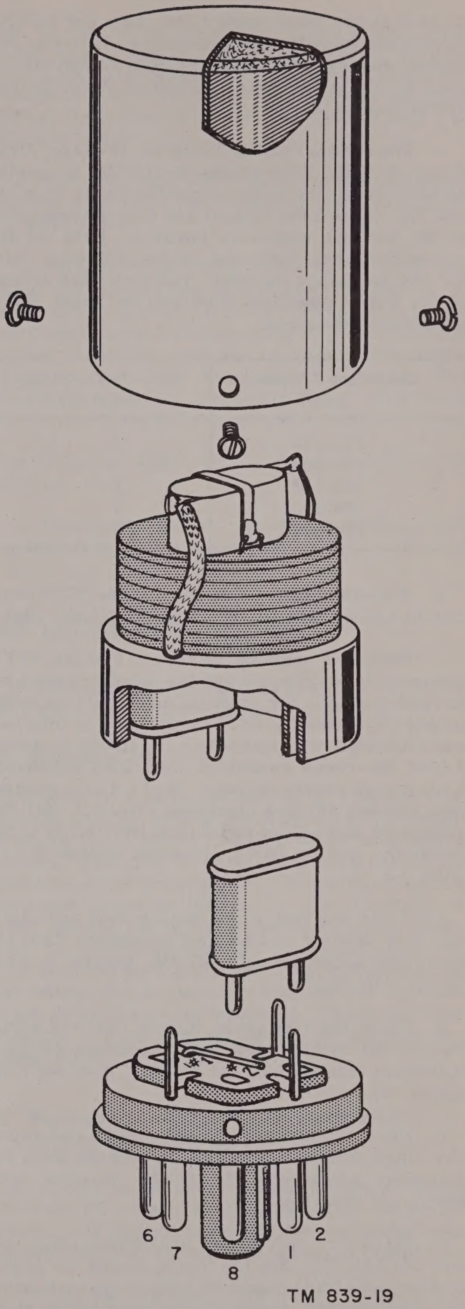

6
7
8
1
2
TM 839-19

Figure 9. Radio Transmitters T-278/U and T-416/GR crystal oven HR401, exploded view.

sensitivity of at least 1,000 ohms per volt for measuring voltage drop across resistors. All control and test points designated in the 500 series, such as J501, C514, etc., pertain to Radio Transmitter T-416/GR.

a. The FINAL PLATE TUNE capacitor C448 (C514 in Radio Transmitter T-416/GR) is located directly above the power-amplifier tubes (figs. 26 and 31). Loosen the locknut and turn the capacitor to the extreme clockwise position. Back off the number of turns indicated on the following chart for the frequency desired. The plate tank circuit of the power amplifier then will be tuned to approximate resonance.

Operating frequency (mc)	Capacitor setting (in turns)
152-158	1
158-162	1-1/2
162-166	2
166-170	3
170-174	10

b. Turn the TEST-OFF switch to the TEST position to apply power to the transmitter (par. 18g).

c. With the common terminal of the VTVM grounded to the chassis and the selector switch set to read negative d-c voltage, place the test probe in jack J401. See figure 37 for location of this jack and all the following test points and tuning controls. Adjust the phase modulator plate load impedance Z401 for maximum voltage. Note this voltage, then detune Z401 in a clockwise direction until the voltage at jack J401 is reduced to two-thirds of the maximum noted above. Nominal voltage is -3.5 volts d-c.

d. Place the test probe in jack J402 and adjust the first doubler plate load impedance Z402 for maximum indication on the VTVM. Nominal voltage is -22 volts d-c.

e. Place the test probe in jack J403 and adjust the second doubler plate load impedance Z403 for maximum indication on the VTVM. Nominal voltage is -28 volts d-c.

f. Place the test probe in jack J404 and adjust the third doubler plate load impedance Z404 for maximum indication on the VTVM. Nominal voltage is -75 volts d-c.

g. Place the test probe in DRIVER GRID test jack J405 (J501). Set the tuning slug of the fourth doubler plate load impedance Z405 at approximately the same physical position as the other tuning slugs (Z401, Z402, Z403, Z404). Adjust the DRIVER GRID TUNE capacitor C429 (C502) for maximum indication on the VTVM. Adjust Z405 for maximum indication on the VTVM. Some interaction between Z405 and C429 (C502) may be present, so that slight readjustment between the two may be necessary to obtain maximum indication. Nominal voltage at this stage is -55 volts d-c.

h. Place the test probe in FINAL GRID jack J406 (J502) and adjust FINAL GRID TUNE 1 capacitor C439 (C509) and FINAL GRID TUNE 2 capacitor C437 (C508), then DRIVER PLATE TUNE capacitor C436 (C507) for maximum indication on the VTVM. Nominal voltage is -57 volts d-c.

Note. FINAL GRID TUNE capacitors should be adjusted to approximately equal capacity by keeping the shaft slots parallel.

i. Turn TEST-OFF switch to the OFF position.

Caution: High d-c voltage is present on the BAL and PL CUR test jacks used in the following steps.

j. Connect a voltmeter (1,000 ohms per volt or better) across the PL CUR test jacks J409 and J410 (J505 and J506); observe proper polarity. Set the voltmeter selector switch to read approximately 2.5 volts d-c. The meter will read 100-ma plate current per volt indicated.

k. Set the FINAL PLATE TUNE control at the center of its range.

l. Turn the TEST-OFF switch to the TEST position.

m. Adjust the final plate capacitor C448 (C514) for minimum indication on the voltmeter.

n. Turn the TEST-OFF switch to the OFF position and tighten the locknut on capacitor C448 (C514).

o. Turn the TEST-OFF switch to the TEST position.

p. Adjust the FINAL PLATE TUNE control for minimum indication on the voltmeter.

q. Adjust the ANT. TUNE capacitor C451 (C517) for maximum voltmeter indication. If no voltage rise is noted, increase the COUPLING control by turning toward MAX and repeat adjustment of the ANT. TUNE control.

r. Turn the TUNE-OPR switch to OPR and observe the voltmeter reading. Adjust the COUPLING control toward MAX until 100 ma of plate current is indicated (1 volt d-c on meter). For Radio Transmitter T-416/GR the COUPLING control should be adjusted for 180 to 200 ma.

s. Readjust the FINAL PLATE TUNE control for minimum indication on the voltmeter.

t. Readjust the ANT. TUNE for a maximum indication on the voltmeter.

u. Repeat steps outlined in subparagraphs s and t above to satisfy both conditions. Do not change either the FINAL PLATE TUNE or ANT. TUNE after completing this adjustment.

v. Increase the COUPLING control toward MAX until the voltmeter indicates 1.4 volts dc which corresponds to 140 ma. For Radio Transmitter T-416/GR, increase the COUPLING control until 190 ma is indicated (1.9 volts).

w. Turn the TEST-OFF switch to the OFF position.

x. Disconnect the voltmeter from PL CUR jacks and connect it across BAL jacks J407 and J408 (J503 and J504 in Radio Transmitter T-416/GR).

y. Turn the TEST-OFF switch to the TEST position. If plate current of the power amplifier tubes is balanced, the voltmeter across the BAL jacks will read zero. If a deflection is noted at BAL jacks, turn FINAL GRID TUNE 1 in a direction to reduce the deflection. Turn FINAL GRID TUNE 2 in the opposite direction to bring the grid circuit back to resonance, as indicated by maximum voltage on the VTVM at the FINAL GRID test jack. Repeat the adjustment of FINAL GRID TUNE 1 to obtain a balance.

z. Turn the TEST-OFF switch to the OFF position and connect the voltmeter test leads to the PL CUR jacks.

aa. Turn the TEST-OFF switch to the TEST position and observe the voltmeter indication. If necessary, readjust the COUPLING control to obtain a reading of 1.4 volts. This is proportional to 140 ma of plate current and represents the proper loading for Radio Transmitter T-278/U. The transmitter now is completely tuned. For Radio Transmitter T-416/GR the proper loading is 190 ma.

bb. Turn the TEST-OFF switch to the OFF position.

cc. Disconnect meters, reassemble dust covers, and install the transmitter in the case.

Section IV. OPERATION UNDER USUAL CONDITIONS

20. Preliminary Starting Procedure for Radio Transmitters T-278/U and T-416/GR

a. Set the **TEST-OFF** switch to the **OFF** position.

b. Set the **TUNE-OPR** switch to the **OPR** position.

c. Turn the **SQUELCH-OFF** switch on Radio Set Control C-847/U to the **SQUELCH** position.

d. Turn the **VOLUME-OFF** switch on Radio Set Control C-847/U in a clockwise direction toward the **VOLUME** position. Power will be applied to the crystal heater of the transmitter.

e. Select the desired operating frequency by turning the **FREQ** selector switch on Radio Set Control C-847/U to position 1 or 2. Filament power then will be applied to the correct oscillator tube of the transmitter.

21. Starting Procedure for Radio Transmitters T-278/U and T-416/GR

Note. If, during the starting procedure, an abnormal result is obtained, refer to the equipment performance checklist, paragraph 41.

a. Press the push-to-talk switch of Handset **H-33/PT.** The **TRANSMIT** indicator lamp on the control unit should light. Voice transmission now can be accomplished.

b. Releasing the press-to-talk switch turns off the transmitter and the receiver operates.

22. Frequency Changing

Changing to a different operating frequency is accomplished by turning the **FREQ** selector switch on Radio Set Control C-847/U to its alternative position. This may be done at any time during the operation of the transmitter. The initial tuning procedure alines the transmitter for operation under the control of one specific crystal. However, the restriction that the maximum allowable difference between two operating frequencies be held within 500 kc assures that the two crystals do not differ greatly in frequency. Changing to the alternate crystal will not cause any serious detuning of the transmitter.

23. Stopping Procedure for Radio Transmitters T-278/U and T-416/GR

a. Releasing the press-to-talk switch of Handset H-33/PT removes all power from the transmitter, with the exception of one oscillator tube filament and the crystal oven heating element.

b. Turn the **VOLUME-OFF** switch on Radio Set Control C-847/U to the **OFF** position to complete the shut-down of the transmitter.

Section V. OPERATING UNDER UNUSUAL CONDITIONS

24. General

The operation of the transmitter may be difficult in regions where extreme cold, heat, humidity and moisture, and sand conditions prevail. In the following paragraphs instructions are given on procedure for minimizing the effect of unusual operation conditions.

25. Operation in Arctic Climates

Subzero temperatures and climate conditions associated with cold weather affect the efficient operation of the equipment. Instructions and precautions for operation under such adverse conditions follow:

a. Handle the equipment carefully.

b. Keep tube filaments lighted constantly, provided this does not overtax the power supply. Refer to note No. 5 of figure 23 for a jumper connection which will maintain a constant reduced voltage on the tube filaments.

c. When equipment which has been exposed to the cold is brought into a warm room, it will start to sweat and will continue to do so until it reaches room temperature. This condition also arises when the equipment warms up during the day after exposure during a cold night. Dry it thoroughly. Remove any coating of frost which may form.

26. Operation in Tropical Climates

a. In tropical climates, the equipment will be subject to moisture conditions more acute than normal. High relative humidity causes condensation of moisture on the equipment whenever the temperature of the equipment becomes lower than the ambient air. Make frequent checks for moisture. Dry the equipment thoroughly.

b. The fungiproofing on all items must remain unbroken.

27. Operation in Desert Climates

a. Conditions similar to those encountered in tropical climates often prevail in desert areas. Use the same measures to insure proper operation of the equipment.

b. The main problem that arises with equipment operation in desert areas is the large amount of sand, or dust and dirt, which may enter the moving parts of the transmitter controls. Make frequent preventive maintenance checks. Pay particular attention to the condition of the lubrication of the equipment. Excessive amounts of dust, sand, or dirt that come into contact with oil and grease result in grit, which will damage the equipment.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. PREVENTIVE MAINTENANCE SERVICES

28. Scope

This chapter outlines the specific duties and responsibilities of organizational maintenance personnel (operators and repairmen). The two phases of organizational maintenance are the prevention of break-down in the equipment and the repair of any trouble that arises in spite of all precautions. Preventive measures include periodic cleaning, lubrication, and weatherproofing, as well as visual inspection of the electrical and mechanical characteristics of the components. Systematic recording and studying of performance characteristics also is important in the prevention of trouble. The general preventive maintenance techniques (par. 32), can be performed with a minimum of equipment and effort. More extensive trouble shooting and repair procedures will be given in chapter 5.

29. Tools and Materials

The following tools and materials, most of which are supplied in Tool Equipment TC-41, are for use in the maintenance of Radio Transmitters T-278/U and T-416/GR (pars. 34 and 35):

Screw drivers.
Wrenches.
Pliers.
Point file or relay burnishing tool.
Clean cloth.
#0000 sandpaper.
Crocus cloth.
Solvent, Dry Cleaning (SD) (Fed spec No. P-S-661a).

Note. Gasoline will not be used as a cleaning fluid for any purpose. Solvent (SD) is available as a cleaning fluid through established supply channels.

30. Special Tools and Materials

a. An alinement tool suitable for h-f (high-frequency) adjustments is necessary for tuning the tank circuits of the transmitter. Emergency alinement tools should contain as little metal as possible.

b. A 20-conductor patch cord, terminated with male and female connectors, is required to supply power to the transmitter when it is removed from the case of the radio set. It is necessary to remove

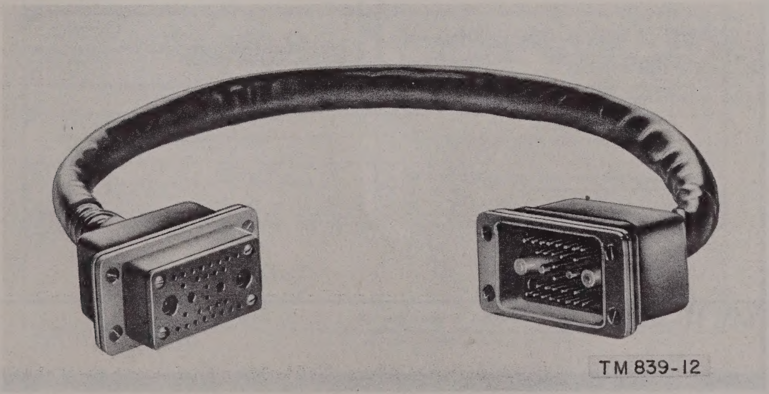
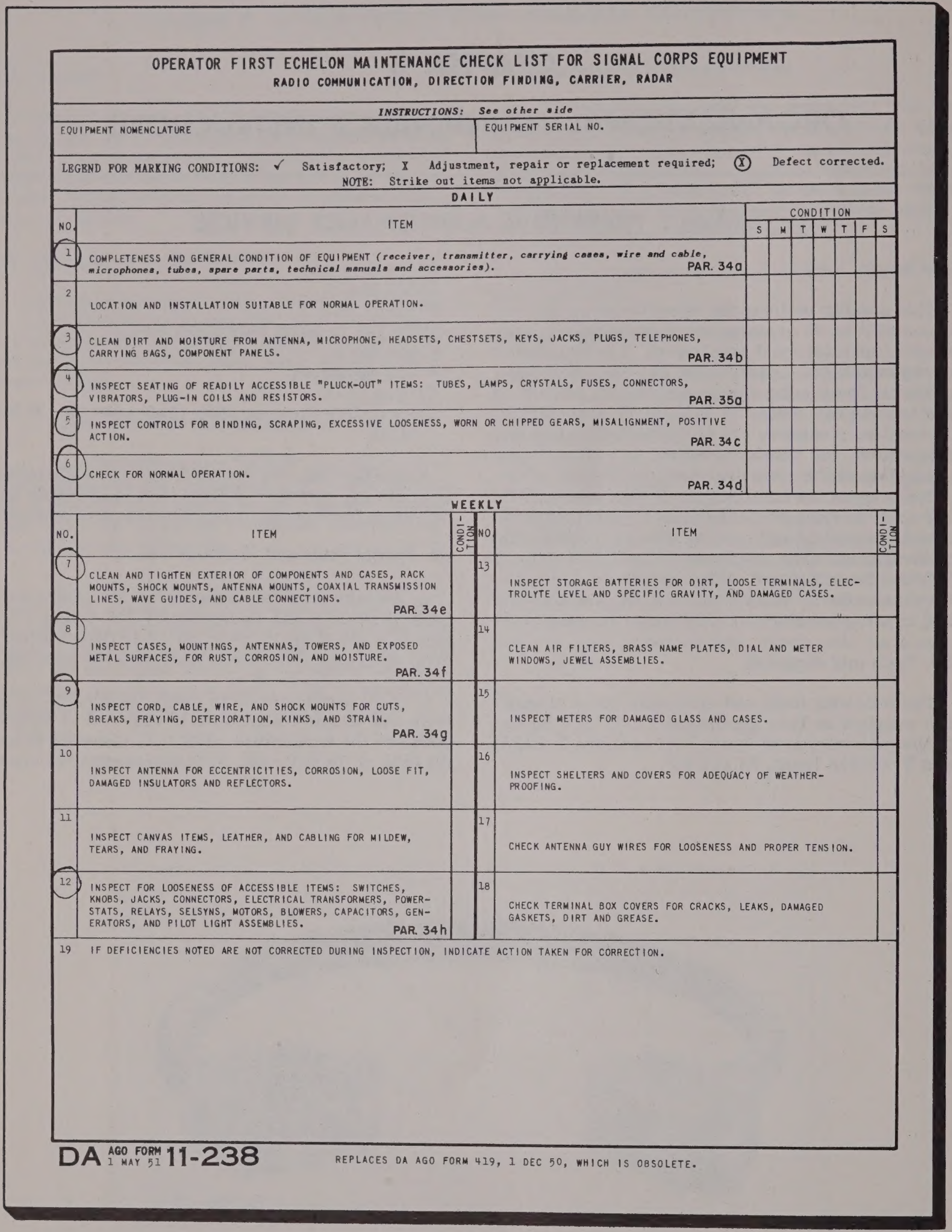


Figure 10. Patch cord.



OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION						
		S	M	T	W	T	F	S
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 34a							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.							
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 34b							
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 35a							
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 34c							
⑥	CHECK FOR NORMAL OPERATION. PAR. 34d							

WEEKLY

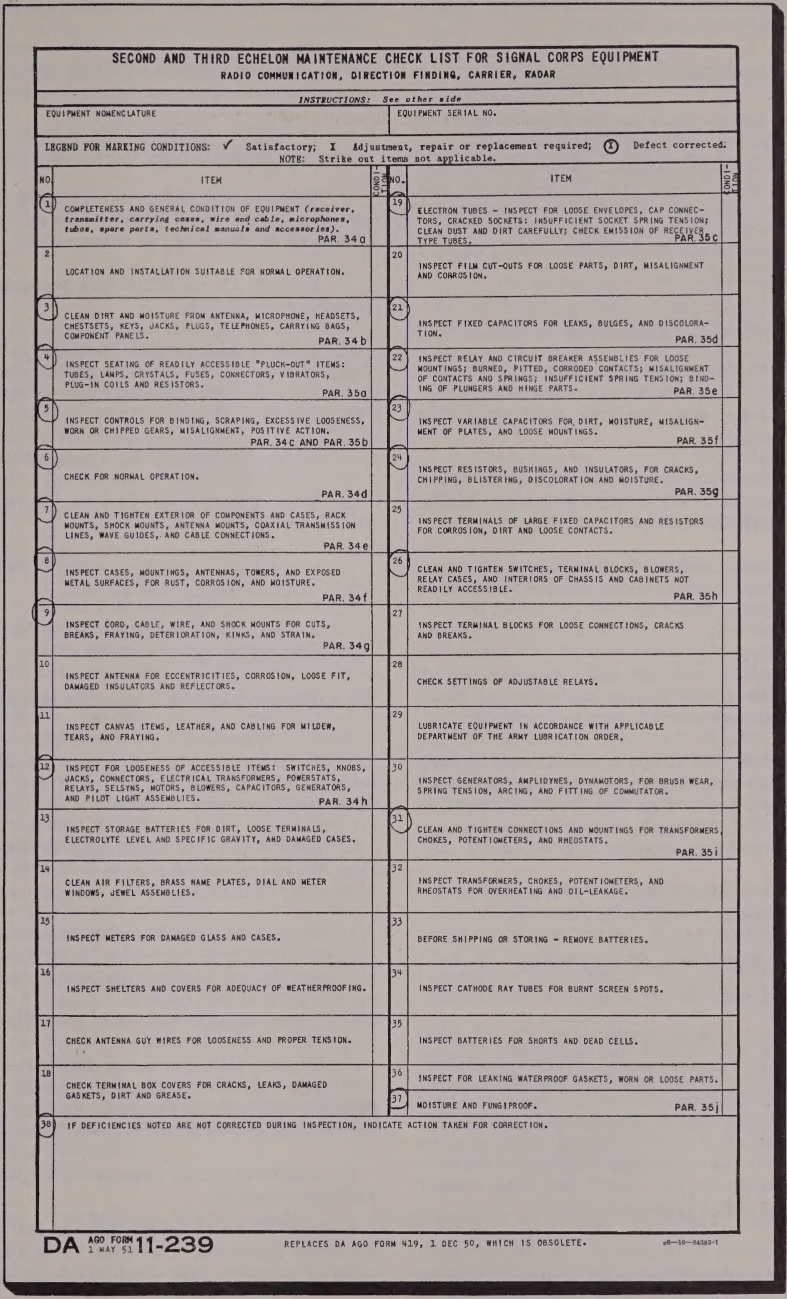
NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 34e		13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.	
⑧	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 34f		14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	
⑨	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 34g		15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	
⑫	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 34h		18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA AGO FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM 839-49

Figure 11. DA AGO Form 11-238.



SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.
NOTE: Strike out items not applicable.

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
①	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (*receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories*). PAR. 34a		⑲	ELECTRON TUBES – INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS: INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES. PAR. 35c	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.		20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
③	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 34b		㉑	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 35d	
④	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 35a		㉒	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 35e	
⑤	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 34c AND PAR. 35b		㉓	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS. PAR. 35f	
⑥	CHECK FOR NORMAL OPERATION. PAR. 34d		㉔	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 35g	
⑦	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 34e		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS.	
⑧	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 34f		㉖	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 35h	
⑨	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 34g		27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS AND BREAKS.	
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.		28	CHECK SETTINGS OF ADJUSTABLE RELAYS.	
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.		29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	
⑫	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 34h		30	INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.	
13	INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.		㉛	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS. PAR. 35i	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE.	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.		33	BEFORE SHIPPING OR STORING – REMOVE BATTERIES.	
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.		35	INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.	
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.		36	INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.	
			㊲	MOISTURE AND FUNGIPROOF. PAR. 35j	

㊳ IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA AGO FORM 1 MAY 51 11-239 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE. o6—16—84382-1

TM 839-50

Figure 12. DA AGO Form 11-239.

the transmitter from the case during the tuning procedure and for repair purposes.

31. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from trouble shooting and repair since its object is to prevent certain troubles from occurring. See AR 750-5.

32. General Preventive Maintenance Techniques

a. Use #0000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or a dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with solvent (SD); then wipe the parts with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride; then wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure adequate ventilation is provided.

c. If available, dry compressed air may be used at a line pressure not exceeding 60 psi (pounds per square inch) to remove dust from inaccessible places; be careful, however, or mechanical damage from the air blast may result.

d. For further information on preventive maintenance techniques, refer to TB SIG 178.

33. Use of Preventive Maintenance Forms
(figs. 11 and 12)

a. The decision as to which items on DA AGO Forms 11-238 and 11-239 are applicable to this equipment is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative, and in the case of second and third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled items in figures 11 and 12 are partially or totally applicable to the transmitting equipment. References in the ITEM block refer to paragraphs in the text which contain additional maintenance information.

34. Performing Exterior Preventive Maintenance

Caution: Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

a. Check for completeness of equipment; spare parts, technical manual and accessories.

b. Remove dirt and moisture from all jacks and controls on the front panel. Inspect plug P401 (P501) on the back of the transmitter.

c. Inspect all switches and jacks on the front panel for looseness.

d. Check for normal operation. If abnormal results occur at any point in the operating procedure, refer to the equipment performance checklist (par. 41).

e. Clean and tighten the transmitter case.

f. Inspect metal surfaces for corrosion and moisture.

g. Inspect patch cord for cuts, breaks, fraying, deterioration, kinks, and strain.

h. Inspect for looseness of accessible items; switches, jacks, and connectors.

35. Performing Interior Preventive Maintenance

Caution: Disconnect all power before performing the following operations. Upon completion, reconnect the power and check it for satisfactory operation (par. 62).

a. Inspect the seating of plug-in capacitor C425 (fig. 28) and the crystal oven unit. Check tightness of coaxial connectors at the antenna relay.

b. Inspect FINAL PLATE TUNE machine bolt (fig. 26) for binding, scraping, excessive looseness, damaged thread, and misalinement. Do the same for the COUPLING control. Check for firm contact of shorting bar contact to plate line tubing.

c. Inspect electron tubes for loose envelopes, loose cap connectors, cracked sockets, and insufficient socket spring tension; clean all parts carefully; check emission of receiver type tubes (fig. 4).

d. Inspect all fixed capacitors for leaks, bulges, and discoloration.

e. Inspect the antenna relay in the transmitter for loose mounting, corroded contacts, misalinement of contacts, and insufficient spring tension.

f. Inspect the variable capacitors for dirt, moisture, misalinement of plates, and loose mountings.

g. Inspect resistors and insulators for cracks, chipping, blistering, discoloration, and moisture.

h. Clean and tighten switches, antenna relay mount, and interior components.

i. Clean and tighten connections and mounting of power-amplifier plate line tubing. Check mounting of transformer T401 and potentiometer R452 (fig. 28).

j. Check moisture and fungiproofing to see that it is unbroken.

k. If the deficiencies noted are not corrected during inspection, indicate the action taken.

Section II. LUBRICATION

36. Lubrication

The transmitter requires lubrication only on the threaded shaft of the FINAL PLATE TUNE control and the COUPLING control. The thread of these shafts should be cleaned with solvent (SD) every 3 months; use a lint-free cloth dampened with solvent. The thread then should be coated lightly with Grease, Aircraft and Instrument (GL) (spec MIL-G-3278). Do not allow electrical contacts to become greasy.

37. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions, such as prevail in tropical, artic, and desert regions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials. Some of the problems encountered are:

(1) Resistors, capacitors, coils, chokes, and transformer windings, fail because of the effects of fungus growth and excessive moisture.

(2) Electrolytic action, often visible in the form of corrosion, takes place in resistors, coils, chokes, and transformer windings, causing eventual break-down.

(3) Insulation on hook-up wires and cables breaks down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips, causing flash-overs.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and excessive moisture. This treatment is explained in TB SIG 13 and TB SIG 72.

c. Winter Maintenance. Special precautions necessary to prevent poor performance or total operational failure of equipment in extremely low temperature are explained in TB SIG 66 and TB SIG 219.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75.

e. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69. Observe all the precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme heat and cold. Refer to paragraph 36 for lubrication instructions.

38. Rustproofing and Painting

a. The protective covers and front panel of the transmitter are constructed of an aluminum alloy with an iridite finish. Rust conditions normally will not be encountered. Corrosion of any nature should be removed by cleaning with solvent (SD) and crocus cloth or #0000 sandpaper if necessary.

Caution: Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. Should painting be necessary, refer to TM 9-2851 for instructions.

Section III. TROUBLE SHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

39. Scope

a. The trouble shooting and repair work that can be performed at the organizational maintenance level (operators and repairmen) is limited necessarily in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. Accordingly, trouble shooting by the operators is based on the performance of the equipment and the use of the senses in determining such troubles as burned-out tubes, cracked insulators, and other faults.

b. The paragraphs which follow in this section help in determining which stage is at fault and in localizing the fault in that stage to the defective item such as a tube or fuse.

40. Visual Inspection

a. When Radio Transmitters T-278/U or T-416/GR fail to operate properly, a visual examination of the following items ordinarily will determine the faulty part.

(1) Wiring for loose or poorly soldered connections, frayed or burned insulation, or stretched leads.

(2) Terminal boards for broken lugs and signs of arcing.

(3) Split, cracked, or broken crystal holder.

(4) Resistors for blistering or discoloration caused by overheating.

(5) Worn, broken, or disconnected cords or plugs.

(6) Faulty relay contacts.

(7) Wires broken because of excessive vibration.

(8) Defective tubes.

b. When failure is encountered and the cause is not immediately apparent, check as many of the above items as is practicable before starting a detailed examination of the component parts of the system. If possible, obtain information from the operator of the equipment regarding performance at the time trouble appeared.

c. If this inspection does not yield results, use the same procedure on all other components of the system, especially the case, the power supply, and the antenna. Check all fuses.

41. Equipment Performance Checklist

a. General. The equipment performance checklist (subpar. c below) indicates the correct sequence of steps to be taken for operation of the transmitter. The checklist gives the item to be checked, the normal indications, and the corrective measures that can be taken.

b. Action or Condition. The information in this column indicates the components to be checked and the settings of various switches and controls.

c. Normal Indications. The normal indications listed indicate what action occurs in the transmitter. One visible sign, a TRANSMIT indicator lamp, enables the operator to check the performance of the transmitter.

d. Corrective Measures. The corrective measures listed are those that the operator can make without turning the equipment in for repairs. If the set is completely inoperative or if the recommended corrective measures do not yield results, trouble shooting is necessary. Reference is made to the item in the trouble-shooting chart (par. 63) which covers the fault.

e. Checklist.

	Item No.	Item	Action or condition	Normal condition	Corrective measures
PREPARATORY	1	Tubes.	All tubes are in place (fig. 4).		
	2	Crystal.	Proper crystal installed in crystal oven (par. 18e).		
	3	Radio Set AN/VRC-19(*).	All components properly connected (fig. 2).		
	4	Tuning controls of transmitter.	Pretuned to desired operating frequency (pars. 18 and 19).		

	Item No.	Item	Action or condition	Normal condition	Corrective measures
START	5	TEST-OFF switch.	Turned to the OFF position.		
	6	TUNE-OPR switch.	Turned to the OPR position.		
	7	SQUELCH switch of Radio Set Control C-847/U.	Turned to the SQUELCH position.		
	8	VOLUME-OFF switch of Radio Set Control C-847/U.	Turned toward the VOLUME position.	Power is applied to crystal heater of the transmitter.	Check fuses in the case and the power supply. See item 1 of paragraph 63.
	9	FREQ selector switch of Radio Set Control C-847/U.	Tuned to FREQ 1 or FREQ 2, depending on choice of operating frequency.	Power is applied to an oscillator tube filament in the transmitter.	Check fuses in the case and the power supply. See item 2 of paragraph 63.
EQUIP PER	10	Handset H-33/PT.	Switch is pressed for push-to-talk operation.	TRANSMIT indicator lamp on Radio Set Control C-847/U lights. Power is applied to transmitter and the system is set up for voice transmission.	Check fuses in the case and the power supply. See items 5 and 7 of paragraph 63.
STOP	11	Handset H-33/PT.	Push-to-talk switch is released.	TRANSMIT indicator lamp of Radio Set Control C-847/U goes out. Main power circuit to transmitter is de-energized.	
	12	VOLUME-OFF switch of Radio Set Control C-847/U.	Turned to the OFF position.	Filament power to oscillator tube and power to crystal heater is removed. Entire system is inoperative.	

CHAPTER 4

THEORY OF OPERATION

42. General

This chapter contains detailed theory of operation for Radio Transmitters T-278/U and T-416/GR with particular emphasis placed upon Radio Transmitter T-278/U as operated in the mobile system of Radio Set AN/VRC-19(*). Because of the numerous interconnections between units of this system, all control circuits for application of power to the transmitter have been traced to their origin. Power supply connections apply to the 6-volt battery-operated Power Supply PP-640/U.

43. Block Diagrams

The system block diagram of Radio Transmitters T-278/U and T-416/GR is shown in figure 2. For more detailed over-all circuit information, refer to figure 13. The signal paths through the transmitter are described briefly in the following subparagraphs.

a. Radio Transmitter T-278/U.

(1) *R-f oscillator.* Two crystal-controlled oscillator stages, V401 and V402, are used to allow a quick change between two predetermined operating frequencies. The oscillator to be used is selected by a switch on Radio Set Control C-847/U (external to the transmitter) which allows filament voltage to be applied to one and removes it from the other. A frequency of 4.75 through 5.4375 mc, depending on the crystal used, is fed to the plate and the control grid of tube V403.

(2) *Phase modulator.* An audio signal from tube V413 (second audio amplifier) also is applied to the control grid of phase modulator tube V403 (subminiature-type tube 5678). With r-f and audio voltages being applied to the grid, a relative phase shift takes place between the signal components at the plate. The output of this stage is phase modulated r-f at the crystal frequency, with a deviation of 468.75 cycles for 100 percent modulation.

(3) *First doubler.* First doubler V404 (subminiature-type tube 5678) has a single tuned plate circuit operating at twice the crystal frequency, with a deviation of 937.5 cycles. This output is applied to the grid of second doubler tube V405.

(4) *Second doubler.* Second doubler V405 (subminiature-type tube 5672) has a single tuned plate circuit operating at four times the crystal frequency, with a deviation of 1,875 cycles. This output is applied to the grid of third doubler tube V406.

(5) *Third doubler.* Third doubler V406 (miniature-type tube 3B4) has a single tuned plate circuit operating at eight times the crystal frequency, with a deviation of 3,750 cycles. This output is applied to the grid of fourth doubler tube V407.

(6) *Fourth doubler.* Fourth doubler V407 (miniature-type tube 3B4) has its plate circuit tuned to 16 times the crystal frequency, with a deviation of 7,500 cycles. Link coupling is used between this stage and the grid of the fifth doubler and driver stage.

(7) *Fifth doubler and driver.* Fifth doubler and driver stage V408 is a type 2E24 tube and has its plate circuit tuned to 32 times the crystal frequency, with a deviation of 15,000 cycles (15 kc). This stage is coupled inductively to the grid circuit of power amplifier tubes V409 and V410.

(8) *Power amplifiers.* The power amplifiers consist of two tubes, V409 and V410, both type 2E24 tubes, operated in push-pull. The plate tank has two tuning adjustments, a capacitor which is preset for the operating frequency and a shorting bar to provide variable inductance for fine tuning. The antenna coupling is adjusted by variable coupling between the plate line and the output link. Power output from the final amplifier passes through an antenna filter to reduce harmonic emission.

(9) *First audio amplifier.* Audio signals from the microphone of Handset H-33/PT, or signals from a radio receiver (retransmission) are applied through an impedance-matching transformer and a high-pass filter to the control grid of first audio-amplifier tube

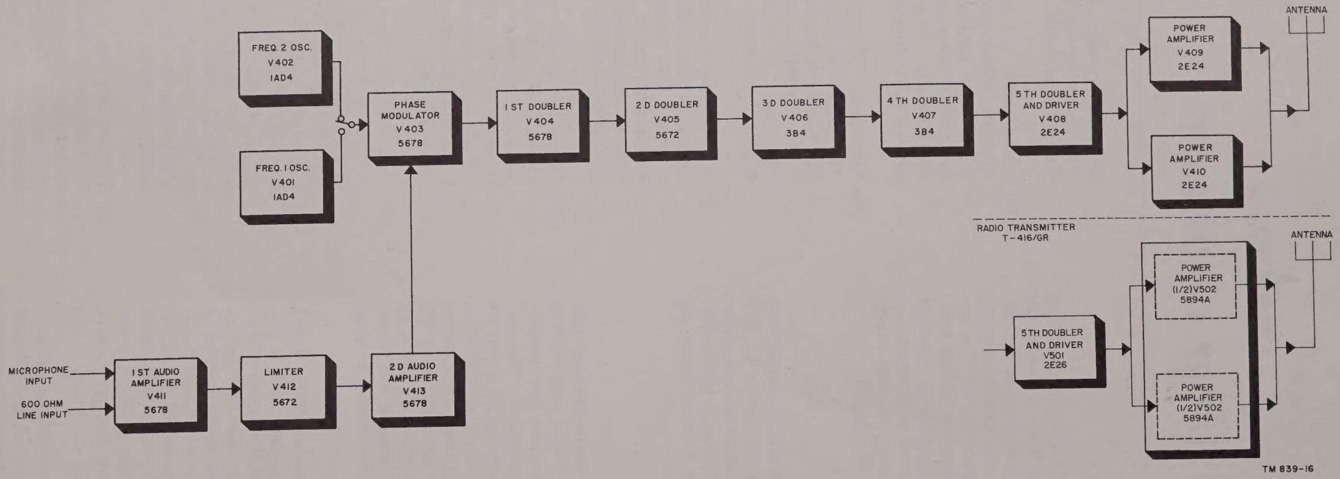

FREQ. 2 OSC.
V402
IAD4
FREQ. I OSC.
V401
IAD4
PHASE
MODULATOR
V403
5678
I ST DOUBLER
V404
5678
2 D DOUBLER
V405
5672
3 D DOUBLER
V406
3B4
4 TH DOUBLER
V407
3B4
5 TH DOUBLER
AND DRIVER
V408
2E24
POWER
AMPLIFIER
V409
2E24
POWER
AMPLIFIER
V410
2E24
ANTENNA
MICROPHONE
INPUT
600 OHM
LINE INPUT
I ST AUDIO
AMPLIFIER
V411
5678
LIMITER
V412
5672
2 D AUDIO
AMPLIFIER
V413
5678
RADIO TRANSMITTER
T-416/GR
5 TH DOUBLER
AND DRIVER
V501
2E26
POWER
AMPLIFIER
(1/2)V502
5894A
POWER
AMPLIFIER
(1/2)V502
5894A
ANTENNA
TM 839-16

Figure 13. Radio Transmitters T-278/U and T-416/GR block diagram.

V411 (type 5678). The output of this stage is coupled to the grid of limiter tube V412.

(10) *Limiter.* Limiter tube V412 is a type 5672 tube and serves to clip the peaks of the audio signal. The output of this tube is passed through a waveshaping network and applied to the second audio amplifier.

(11) *Second audio amplifier.* Second audio-amplifier tube V413 is a type 5678 tube. The audio level of the amplified output of this tube is adjusted by a deviation control and supplied to the grid of the phase modulator tube V403.

b. Radio Transmitter T-416/GR. The block diagram for Radio Transmitter T-416/GR follows the same sequence as the unlettered model. Circuit components are identical in both models up to the fifth doubler and driver stage. From this stage on, other types of tubes are employed to increase the power output of the transmitter. Note the following major changes:

(1) *Fifth doubler and driver.* A type 2E26 tube (V501) is employed, which has its plate circuit tuned to 32 times the crystal frequency with a deviation of 15 kc. This stage is inductively coupled to the grid circuit of power-amplifier tube V502.

(2) *Power amplifier.* The power amplifier consists of a dual-section type 5894A tube (V502). This stage is operated in push-pull, in the same manner as described for Radio Transmitter T-278/U.

44. Crystal Oscillator

(fig. 14)

a. Two crystal-controlled oscillator tubes, V401 and V402, are employed to allow a quick change between two predetermined operating frequencies. Selection of the oscillator to be used is made at Radio Set Control C-847/U, external to the transmitter.

b. When the radio set control VOLUME-OFF switch is turned clockwise toward the VOLUME position, 6 volts d-c is applied to the heating element of crystal oven HR401 through terminals 7 and 8 of P401 or P501. An oven thermostat maintains a uniform temperature for the two inclosed crystals (Y401 and Y402), and thus eliminates any deviation in the crystal operating frequency because of temperature change. The two crystals are 1/32 of the desired transmitter output frequency and do not differ from each other by more than 15.625 kc. The subsequent frequency multiplication of 32 times is therefore held within the allowable 500-kc difference.

c. When the radio set control FREQ selector switch is turned to the FREQ 1 position and the switch of the Handset H-33/PT is pressed for push-to-talk operation, 1.3 volts d-c is applied to the heater-cathode of tube V401 through terminal 11 of P401 or P501. Plate and screen voltage is applied simultaneously through terminal 26 and conduction takes place.

d. One crystal is connected directly between the screen grid and the control grid of tube V401, and acts as a tuned circuit resonant to the operating frequency of the crystal. R-f voltage variations at the oscillator screen are fed back to the crystal through the interelectrode capacity (screen grid to control grid) of the tube and through capacitors C402, C403, and C465. An electrical strain thus is exerted on the crystal so that it vibrates mechanically at its resonant frequency and develops the grid excitation voltage. Energy feedback is sufficient to make up for losses in the resonant circuit so that oscillations continue.

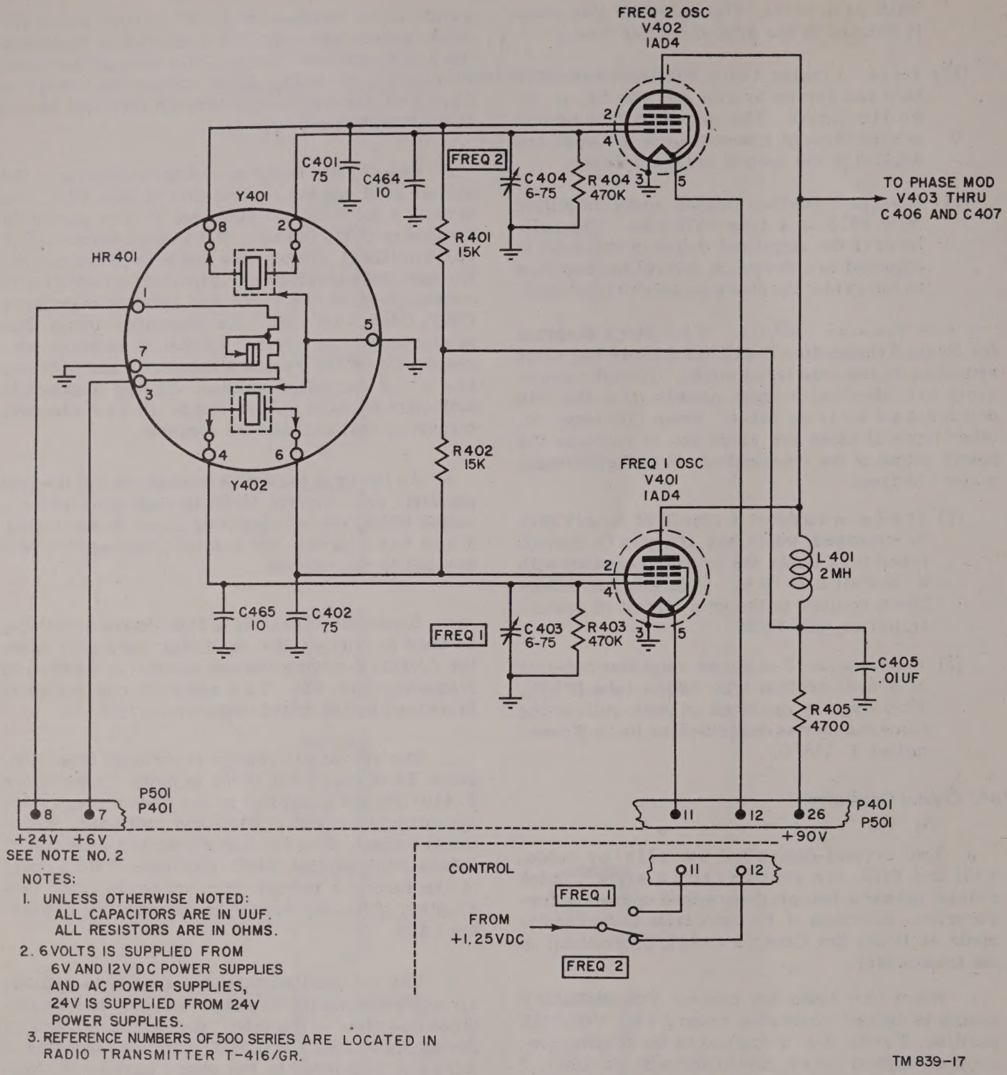
e. As the grid excitation voltage swings the grid positive, grid current flows through grid leak resistor R403, and an operating bias is developed. This bias makes the control grid negative with respect to the cathode.

f. Capacitor C403 (FREQ 1) is variable and may be used to correct the oscillator frequency when the crystal is not oscillating exactly at the desired frequency (par. 68). The range of correction is increased by the added capacity of C465.

g. The d-c supply voltage is obtained from terminal 26 of plug P401 (P501 in Radio Transmitter T-416/GR) and is applied to the plate through voltage-dropping resistor R405 and coil L401. Additional voltage drop for correct screen potential is obtained by resistor R402. Capacitor C402 is part of the feedback circuit from screen to grid. Decoupling of the B+ supply is provided by capacitor C405.

h. The r-f oscillations in the screen-to-cathode circuit modulate the electron flow between the cathode and plate of the tube. R-f output voltage is developed across oscillator plate load inductance L401 and is coupled to the phase modulator stage control grid through capacitor C406 and to the plate of the phase modulator tube through capacitor C407.

i. Changing to FREQ 2 at the control unit switches filament voltage from tube V401 to tube V402. This action disables tube V401 by removing the filament power and, in effect, substitutes a crystal of different frequency into another oscillator circuit. This circuit is composed of tube V402, together with associated components and circuits identical to those already described for tube V401.


FREQ 2 OSC
V402
1AD4
FREQ 2
C401
75
C464
10
C404
6-75
R 404
470K
Y401
HR 401
R 401
15K
TO PHASE MOD
V403 THRU
C406 AND C407
R402
15K
Y402
FREQ 1 OSC
V401
1AD4
L401
2MH
C465
10
C402
75
FREQ 1
C403
6-75
R403
470K
C405
.01UF
R405
4700
P501
P401
+24V
+6V
SEE NOTE NO. 2
P401
P501
+90V
CONTROL
FREQ 1
FROM
+1.25VDC
FREQ 2
TM 839-17

NOTES:

1. UNLESS OTHERWISE NOTED:
   ALL CAPACITORS ARE IN UUF.
   ALL RESISTORS ARE IN OHMS.
2. 6VOLTS IS SUPPLIED FROM
   6V AND 12V DC POWER SUPPLIES
   AND AC POWER SUPPLIES,
   24V IS SUPPLIED FROM 24V
   POWER SUPPLIES.
3. REFERENCE NUMBERS OF 500 SERIES ARE LOCATED IN
   RADIO TRANSMITTER T-416/GR.

Figure 14. Radio Transmitters T-278/U and T-416/GR crystal oscillator, simplified schematic.

45. Phase Modulator
(fig. 15)

a. The output of the oscillator is impressed on the control grid of phase modulator tube V403 by means of a d-c blocking capacitor C406. Because of the action of the tube, an output voltage appears at the plate which is 180° out of phase with the input voltage. The oscillator output also is coupled directly to the plate of tube V403 by means of d-c blocking capacitor C407. Two voltages which are nearly 180° out of phase are therefore present at the plate of tube V403.

b. The magnitudes of these two voltages are approximately equal, because of the application of

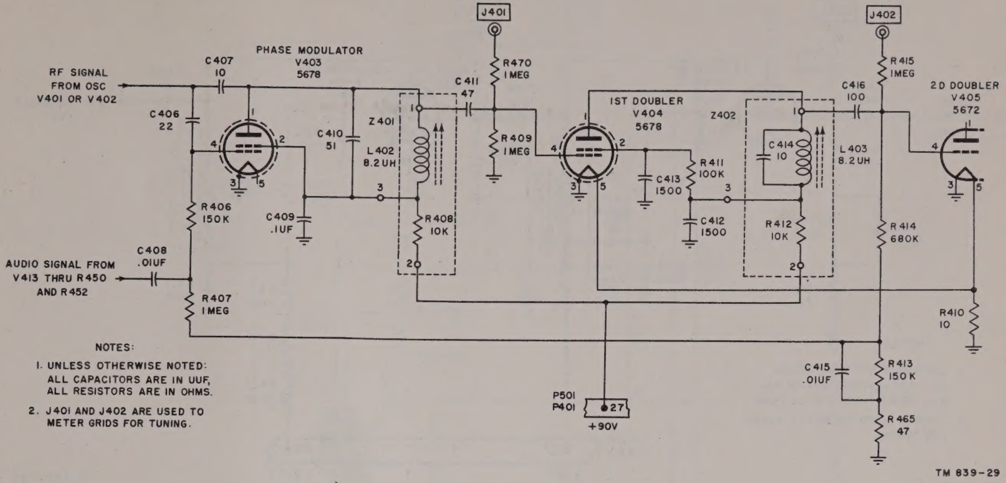

J401
J402
PHASE MODULATOR
V403
5678
RF SIGNAL
FROM OSC
V401 OR V402
C407
10
C406
22
C411
47
R470
1 MEG
Z401
C410
51
L402
8.2UH
R409
1 MEG
1ST DOUBLER
V404
5678
Z402
C416
100
R415
1MEG
2D DOUBLER
V405
5672
C414
10
L403
8.2UH
R411
100K
C413
1500
C412
1500
R412
10K
R414
680K
R406
150K
C409
.1UF
R408
10K
C408
.01UF
AUDIO SIGNAL FROM
V413 THRU R450
AND R452
R407
1 MEG
NOTES:
1. UNLESS OTHERWISE NOTED:
ALL CAPACITORS ARE IN UUF,
ALL RESISTORS ARE IN OHMS.
2. J401 AND J402 ARE USED TO
METER GRIDS FOR TUNING.
R410
10
C415
.01UF
R413
150K
P501
P401
27
+90V
R465
47
TM 839-29

Figure 15. Radio Transmitters T-278/U and T-416/GR modulator and first doubler, simplified schematic.

a negative bias to the grid through resistors R407 and R406. This bias determines the initial operating point of the tube. During modulation, audio voltage input to the control grid of tube V403 varies the bias, which in turn varies the transconductance of the tube at an audio rate. This action changes the phase relationship between the two voltages at the plate of tube V403 and produces a resultant plate voltage which varies the phase in synchronism with the a-f (audio frequency) modulating voltage.

c. Audio signals from tube V413 are coupled to grid of phase modulator tube V403 through blocking capacitor C408 and resistor R406 (par. 51). Plate voltage for tube V403 is obtained from terminal 27 of P401 or P501 through inductance L402. Capacitor C410 is a part of the plate tank circuit. This tank circuit is not made resonant, but is detuned slightly to provide an inductive reactance. Resistor R408 acts as an isolating and decoupling resistor to prevent r-f voltages from entering the plate supply, and capacitor C409 bypasses the r-f plate circuit to ground. Blocking capacitor C411 couples the phase modulator output to the first doubler stage.

46. Frequency Multiplication

The output of the modulator stage is phase modulated rf at the crystal frequency. The frequency deviation at this point is 1/32 of the overall output deviation for 100 percent modulation. Subsequent frequency multiplication of 32 times is necessary to produce the desired 15-kc deviation at the output frequency. This is accomplished by the following frequency doubler stages.

a. First Doubler (fig. 15). The output of the phase modulator circuit is fed to the control grid of first doubler tube V404 through blocking capacitor C411. Grid current flowing through grid leak resistor R409 provides operating bias. The magnitude of this bias depends on the signal output of the phase modulator circuit. Since greater grid drive produces higher values of negative bias, it is possible to determine the relative level of the input signal by measuring the bias voltage. Test jack J401 is connected through isolating resistor R470 to the control grid of tube V404 for this purpose. Resistor R410 is a shunt resistance across the filament supply of tubes V404 through 407 to provide correct filament current. Plate voltage for tube V404 is obtained from terminal 27 of P401 or P501 through decoupling resistor R412, which is bypassed for r-f voltages by capacitor C412, and through coil L403. The tuned circuit composed of capacitor C414 and variable inductance L403 is resonated at twice the crystal frequency. Resistor R411 is the screen voltage-dropping resistor. Capacitor C413 bypasses the screen grid to ground. The output voltage developed across plate load impedance Z402 is coupled to the control grid of tube V405 by capacitor C416.

b. Second Doubler (fig. 16). Tube V405 doubles the frequency of the previous stage. The plate circuit is tuned to four times the crystal frequency by variable plate load inductance L404. Signal output from the previous stage (V404) is applied to the control grid of tube V405 through d-c blocking capacitor C416. Grid current flowing through grid leak resistor R414 provides operating bias and indicates the relative level of the input signal.

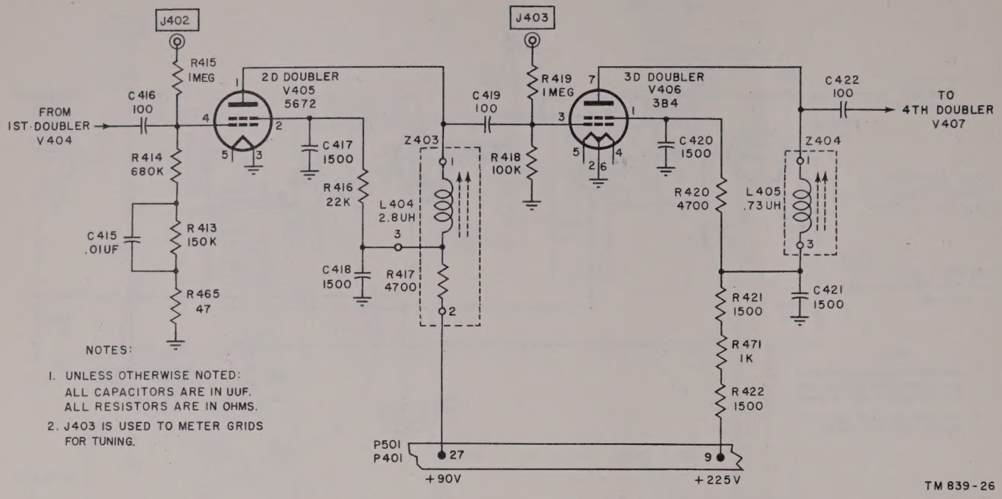

J402
R415
IMEG
2D DOUBLER
V405
5672
C416
100
FROM
IST DOUBLER
V404
4
1
2
5
3
R414
680K
C417
1500
R416
22K
Z403
L404
2.8UH
3
C415
.01UF
R413
150K
C418
1500
R417
4700
2
R465
47
NOTES:
1. UNLESS OTHERWISE NOTED:
ALL CAPACITORS ARE IN UUF.
ALL RESISTORS ARE IN OHMS.
2. J403 IS USED TO METER GRIDS
FOR TUNING.
J403
R419
IMEG
C419
100
R418
100K
7
3D DOUBLER
V406
3B4
3
1
5
2
6
4
C420
1500
R420
4700
C422
100
TO
4TH DOUBLER
V407
Z404
1
L405
.73UH
3
C421
1500
R421
1500
R471
IK
R422
1500
P501
P401
27
9
+90V
+225V
TM 839-26

Figure 16. Radio Transmitters T-278/U and T-416/GR second and third doublers, simplified schematic.

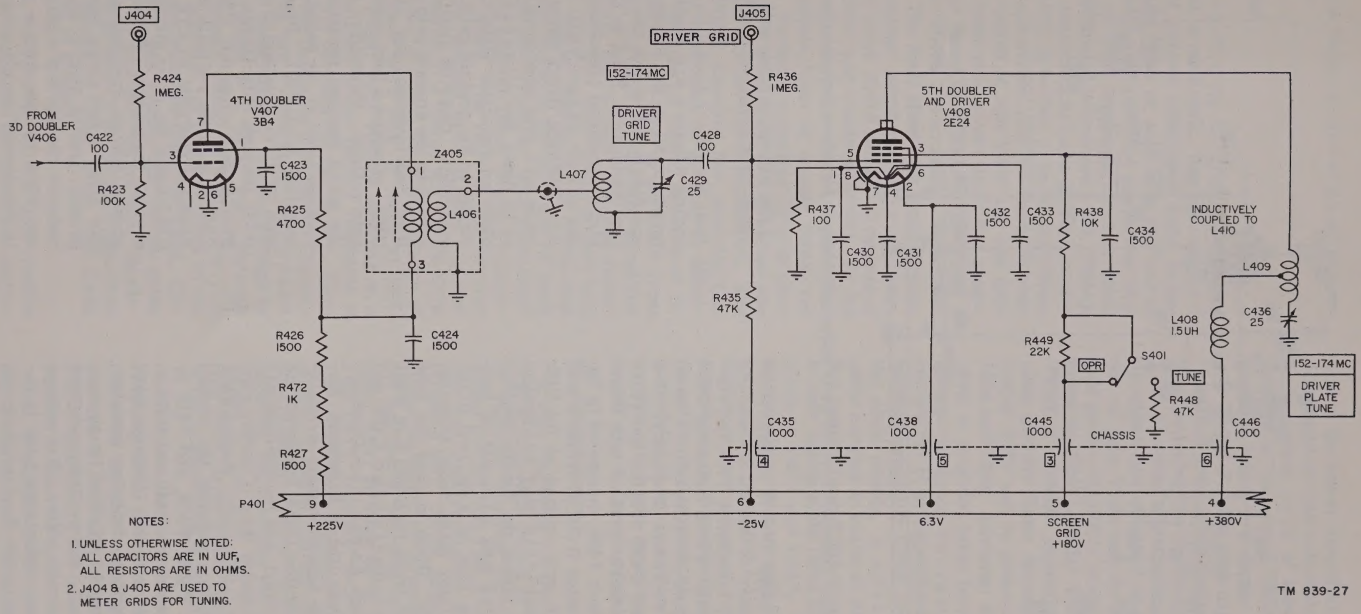
This level is checked at jack J402, connected to the control grid through isolating resistor R415. Voltage indications at this test point are used when tuning the first doubler stage. Plate voltage for tube V405 is obtained from terminal 20 of P401 or P501 through decoupling resistor R417, which is bypassed for r-f voltages by capacitor C418 and through coil L404. Resistor R416 is the screen voltage-dropping resistor. Capacitor C417 bypasses the screen grid to ground. R-f voltage developed across plate load impedance Z403 is coupled to the control grid of tube V407 by d-c blocking capacitor C419.

c. Third Doubler (fig. 16). Tube V407 doubles the frequency of the previous stage. The plate circuit is tuned to eight times the crystal frequency by the variable inductance L405. Signal output from the previous stage (V405) is applied to the control grid of tube V406 through d-c blocking capacitor C419. Grid current flowing through grid leak resistor R418 provides operating bias and indicates the relative level of the input signal. This level is checked at jack J403, connected to the control grid through isolating resistor R419. Voltage indications at this test point are used as a guide when tuning the second doubler stage. Voltage for tube V406 is obtained from terminal 9 of P401 or P501 through inductance L405. Capacitor C421 bypasses the r-f plate circuit to ground, and resistors R421, R471, and R422 act as isolating and decoupling resistors to prevent r-f voltages from getting into the plate supply. Resistor R420 is the screen voltage-dropping resistor. Capacitor C420 bypasses the screen grid to ground. R-f voltage developed across plate load impedance Z404 is coupled to the control grid of tube V407 by d-c blocking capacitor C422.

d. Fourth Doubler (fig. 17). Tube V407 doubles the frequency of the previous stage. The plate circuit is tuned to 16 times the crystal frequency by variable inductance L406. Signal output from the previous stage (V406) is applied to the control grid of tube V407 through d-c blocking capacitor C422. Grid current flowing through grid leak resistor R423 provides operating bias and indicates the relative level of the input signal. This level is check at jack J404, connected to the control grid through isolating resistor R424. Voltage indications at this test point are used as a guide when tuning the third doubler stage. Plate voltage for tube V407 is obtained from terminal 9 of P401 or P501 through the primary of tank coil inductance L406. Decoupling of the plate supply is provided by capacitor C424 and resistors R426, R472, and R427. Resistor R425 is the screen voltage-dropping resistor. Capacitor C423 bypasses the screen grid to ground. R-f voltage developed across the primary of plate load impedance Z405 is coupled inductively to the grid tank circuit of tube V408.

e. Fifth Doubler and Driver (fig. 17).

(1) *Radio Transmitter T-278/U.* Tube V408 doubles the frequency of the previous stage. The plate circuit is tuned to 32 times the crystal frequency by variable DRIVER PLATE TUNE capacitor C436. Signal output from


J404
R424
1MEG.
FROM
3D DOUBLER
V406
C422
100
R423
100K
4TH DOUBLER
V407
3B4
7
3
1
4
2
6
5
C423
1500
R425
4700
Z405
1
2
3
L406
C424
1500
R426
1500
R472
1K
R427
1500
P401
9
+225V
L407
DRIVER GRID
152-174 MC
DRIVER
GRID
TUNE
C428
100
C429
25
J405
R436
1MEG.
R435
47K
C435
1000
4
6
-25V
5TH DOUBLER
AND DRIVER
V408
2E24
5
3
1
8
7
4
6
2
R437
100
C430
1500
C431
1500
C432
1500
C433
1500
R438
10K
C434
1500
C438
1000
5
1
6.3V
R449
22K
OPR
S401
TUNE
R448
47K
C445
1000
3
CHASSIS
5
SCREEN
GRID
+180V
INDUCTIVELY
COUPLED TO
L410
L409
L408
1.5UH
C436
25
152-174 MC
DRIVER
PLATE
TUNE
C446
1000
6
4
+380V

NOTES:

1. UNLESS OTHERWISE NOTED:
   ALL CAPACITORS ARE IN UUF,
   ALL RESISTORS ARE IN OHMS.
2. J404 & J405 ARE USED TO
   METER GRIDS FOR TUNING.

TM 839-27

Figure 17. Radio Transmitter T-278/U, fourth doubler and fifth doubler and driver, simplified schematic.

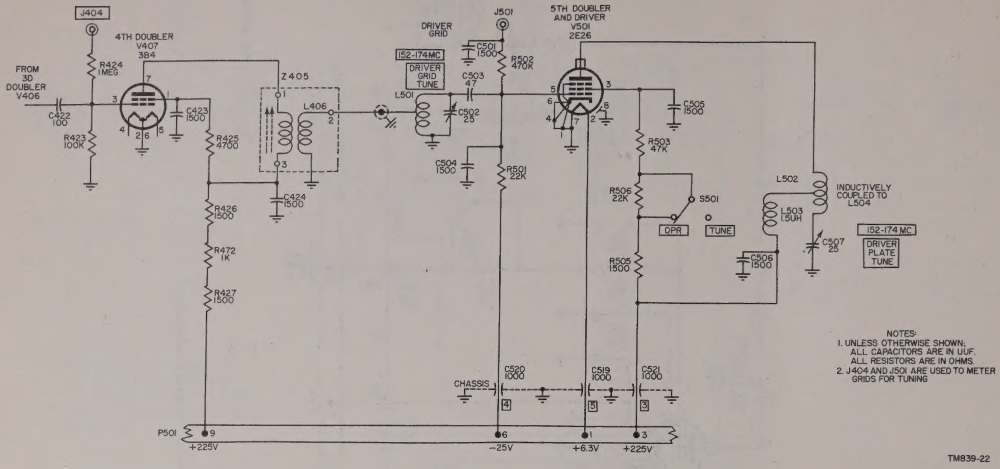

J404
4TH DOUBLER
V407
3B4
FROM 3D DOUBLER V406
R424 1MEG
C422 100
R423 100K
C423 1500
R425 4700
Z405
L406
C424 1500
R426 1500
R472 1K
R427 1500
J501
DRIVER GRID
152-174MC
DRIVER GRID TUNE
C501 1500
R502 470K
C503 47
L501
C502 25
C504 1500
R501 22K
5TH DOUBLER AND DRIVER
V501
2E26
C505 1500
R503 47K
R506 22K
S501
OPR
TUNE
L502
L503 1.5UH
INDUCTIVELY COUPLED TO L504
152-174MC
DRIVER PLATE TUNE
C507 25
C506 1500
R505 1500
NOTES:
1. UNLESS OTHERWISE SHOWN; ALL CAPACITORS ARE IN UUF. ALL RESISTORS ARE IN OHMS.
2. J404 AND J501 ARE USED TO METER GRIDS FOR TUNING
CHASSIS
C520 1000
C519 1000
C521 1000
P501
+225V
-25V
+6.3V
+225V
TM839-22

Figure 18. Radio Transmitter T-416/GR fourth doubler and fifth doubler and driver, simplified schematic.

the previous stage (V407) is connected from the secondary of inductance L406 to inductance L407. Inductance L407 and variable DRIVER GRID TUNE capacitor C429 make up a grid tank circuit which is tuned to 16 times the crystal frequency. D-c blocking capacitor C428 couples the tank output to the control grid of tube V408. DRIVER GRID jack J405, connected to the grid through resistor R436, provides a test point from which grid voltage at the fifth doubler and driver grid may be checked and is used when tuning the fourth doubler stage and the grid tank circuit of tube V408. Protective bias is applied to the grid through resistor R435 from terminal 6 of P401 or P501. Plate voltage for tube V408 is obtained from terminal 4 of P401 or P501 through inductances L408 and L409. Feedthrough capacitor C446 bypasses the r-f plate circuit to ground. Resistor R438 is the screen voltage-dropping resistor. Capacitor C434 bypasses the screen grid to ground, and feedthrough capacitor C445 decouples the r-f screen circuit from the screen supply. Switch S401 in the TUNE position reduces the screen voltage to tubes V408, V409, and V410 by the addition of resistors R448 and R449 in the screen supply circuit. Resistor R437 is a cathode voltage-dropping resistor. Filament bypassing is provided by capacitors C431 and C432, and by C430 and C433 at the beam forming plates. R-f voltage developed across inductance L409 is inductively coupled to the final grid circuit of the following push-pull power-amplifier stage, thus acting as a driver.

(2) *Radio Transmitter T-416/GR (fig. 18).* All preceding stages are identical to the unlettered model of the transmitter. R-f voltage developed across the primary of plate load impedance Z405 in the fourth doubler stage is coupled inductively to fifth doubler and driver stage V501. Inductance L501 and DRIVER GRID TUNE capacitor C502 make up a grid tank circuit which is tuned to 16 times the crystal frequency. D-c blocking capacitor C503 couples the tank output to the control grid of the type 2E26 tube V501. DRIVER GRID jack J501, connected to the control grid through resistor R502 and bypassed for rf by capacitor C501, provides a test point for measuring grid voltage. Protective bias is applied to the grid through resistor R501, which is bypassed for rf by capacitor C504 from terminal 6 of P501. Plate of voltage for tube V501 is obtained from terminal 3 of P501 through inductances L502 and L503. Feedthrough capacitor C521 and capacitor C506 bypass the r-f plate circuit to ground. Variable DRIVER PLATE TUNE capacitor C507 tunes the plate circuit to 32 times the crystal frequency. Resistor R503 is the screen voltage-dropping resistor. Capacitor C505 bypasses the screen grid to ground. Switch S502 in the TUNE position reduces the screen voltage to tubes V501 and V502 by the addition of resistor R506 in the screen supply circuit. Output volt-

age of this stage is developed across coil L502.

47. Power Amplifier

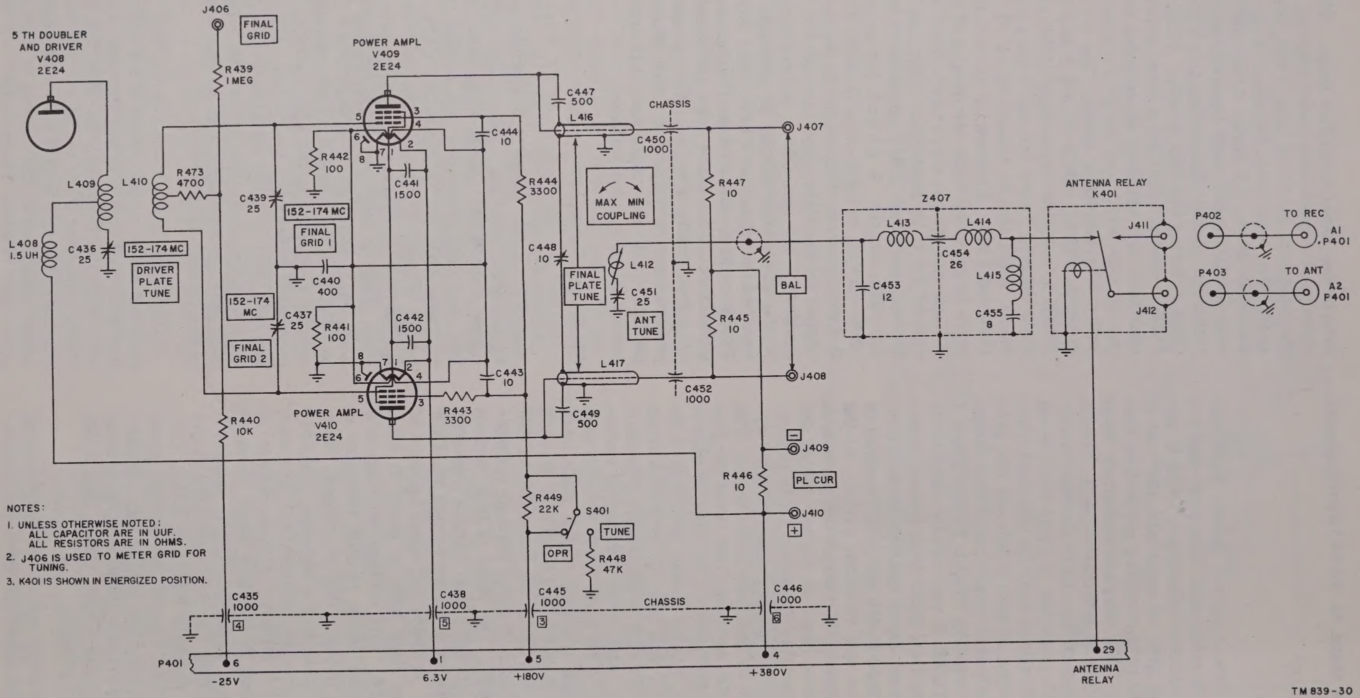
a. Radio Transmitter T-278/U (fig. 19). Tubes V409 and V410 are operated in push-pull. The push-pull r-f voltage developed across inductance L410 is applied to the control grid of each tube 180° out of phase. Each control grid receives protective bias from terminal 6 of P401 through resistors R440 and R473 and a portion of inductance L410. FINAL GRID jack J406, connected to L410 through resistors R473 and R439, provides a test point from which voltage indications may be obtained when tuning the driver output of tube V408 and the grid circuit of the push-pull power amplifier stage. The grid circuit is tuned by FINAL GRID TUNE 1 and FINAL GRID TUNE 2 variable capacitors C439 and C437. The final plate tank circuit operates as a conventional tuned quarter-wave line. The parallel plate lines (L416 and L417) consist of copper tubing, silver and rhodium plated. At the vhf (very-high frequency) for which the plate tank is designed, the plates lines of copper tubing act as an inductance. Variable capacitor C448 is preset at the operating frequency and provides approximate resonance in the plate tank circuit. The FINAL PLATE TUNE shorting bar, used for fine tuning, varies the inductance of the tank by shorting a portion of the plate lines. Division of B+ voltage to the plate of each tube is provided from terminal 4 of P401 through feedthrough capacitor C446, resistor R446, and voltage-dropping resistors R445 and R447. The plate leads to each tube pass through the copper tubing of the plate tank circuit. R-f energy is fed to the open end of each plate line through d-c blocking capacitors C447 and C449. All plate current flows through voltage-dropping resistor R446. The value of this current is indicated by the voltage drop across resistor R446, and is measured by a meter across PL CUR jacks J409 and J410. A check for equal balance of plate current from each tube is made at BAL jacks J407 and J408. Any voltage reading on a meter connected across these jacks indicates a difference of current between the two plates. Zero voltage on the meter indicates a balance. Capacitors C450 and C452 are feedthrough r-f bypass capacitors for the plate supply. Screen voltage is supplied from terminal 5 of plug P401, through feedthrough r-f bypass capacitor C445, switch S401 in the OPR position (or resistor R449 in the TUNE position), and resistor R443, or R444. Capacitors C443 and C444 bypass the screen grids to ground through the filament center tap. Resistors R441 and R442 provide a cathode voltage drop for each tube. Capacitors C440, C441, and C442 bypass the filament to ground.

b. Radio Transmitter T-416/GR (fig. 20). A dual-section type 5894A tube is employed for push-pull operation of the power amplifier stage. The r-f voltage developed across inductance L504 is applied to each control grid of tube V502, together with a protective bias from terminal 6 of P501 through resistor R504, r-f choke L505, and a portion of coil L504. Feedthrough capacitor C520 and capacitor C510 provide decoupling to prevent r-f voltage from entering the bias supply. FINAL GRID jack J502 provides a test point from which voltage indications are obtained when tuning the driver output of tube V501 and the grid circuit of the push-pull power-amplifier stage. The grid circuit is tuned by FINAL GRID TUNE 1 and FINAL GRID TUNE 2 variable capacitors C509 and C508. All plate current flows through voltage-dropping resistor R509 and is measured at PL CUR jacks J505 and J506. Division of B+ voltage to each plate is provided from terminal 4 of P501 through voltage-dropping resistors R507 and R508 bypassed for rf by capacitors C516 and C515. Feedthrough capacitor C518 prevents rf from entering the plate supply. A check for equal balance of plate current is made at BAL jacks J503 and J504. R-f energy from V502 is fed to the open end of the copper tubing plate lines through d-c blocking capacitors C512 and C513. Approximate resonance of the plate tank circuit is provided by preset variable capacitor C514. The FINAL PLATE TUNE control shorts out the desired amount of inductance on the plate lines and therefore serves as a fine tuning control. The screen grid is bypassed for rf by capacitor C523. Feedthrough capacitor C519 and capacitor C511 maintain the heater at r-f ground potential.

48. Output Stage

a. Radio Transmitter T-278/U (fig. 19). Antenna coupling of the power output of the amplifier is adjusted by variable coupling between the plate lines and output COUPLING (MAX-MIN) link L412. Output link and load reactance are series resonated by variable ANT. TUNE capacitor C451. The power output is applied to the antenna through filter Z407, the function of which is to reduce harmonic emission. Z407 is made up of inductances L413, L414, and L415, together with capacitors C453, C454, and C455. This network allows passage of the operating frequency to the antenna relay, but diverts generated harmonics to ground. During transmission, two contacts on antenna relay K401 are closed to complete the circuit to terminal A2 of plug P401, from which point case connections lead to the transmitting antenna.

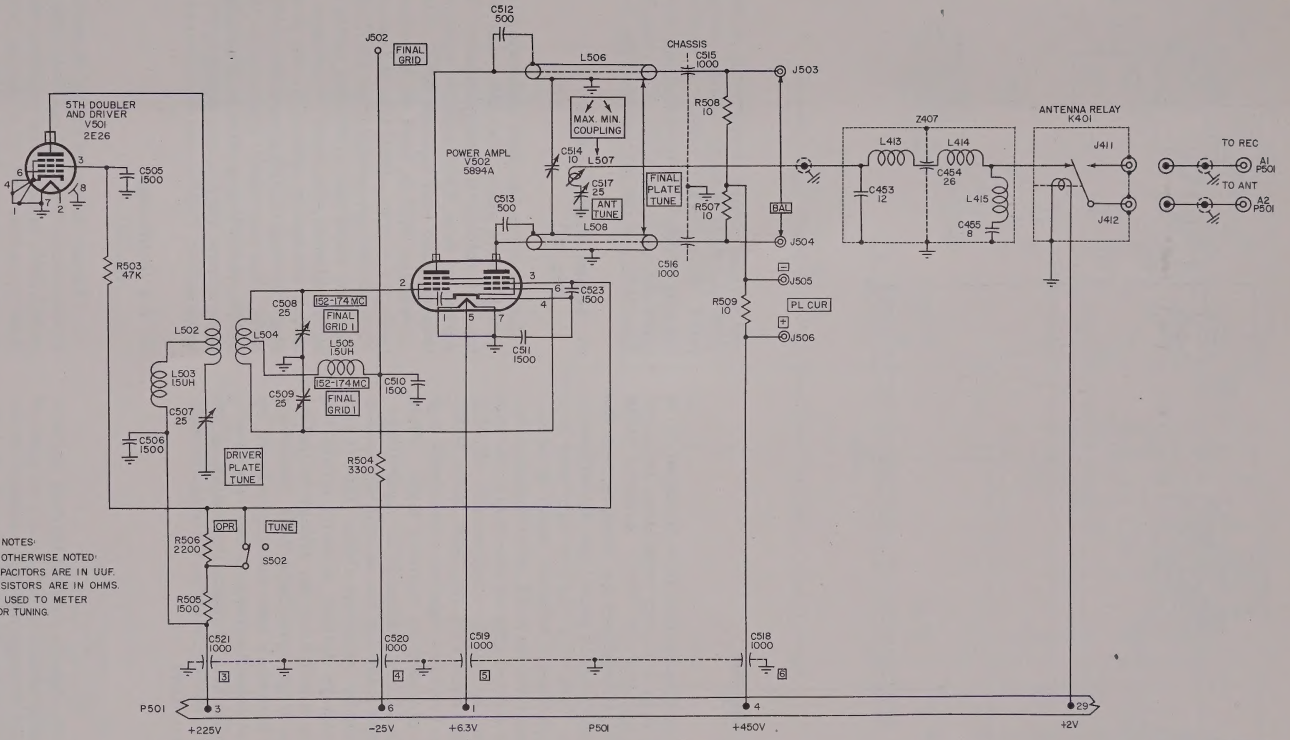
b. Radio Transmitter T-416/GR (fig. 20). Antenna coupling of the power output of the amplifier is adjusted by variable coupling between the plate lines and output COUPLING (MAX-MIN) link L507. ANT. TUNE capacitor C517 tunes out the inductive reactance of the link coil at series resonance. Power output is applied to the antenna in a manner identical to that of Radio Transmitter T-278/U.


5 TH DOUBLER
AND DRIVER
V408
2E24
J406
FINAL GRID
R439
1 MEG
POWER AMPL
V409
2E24
C447
500
L416
CHASSIS
J407
C450
1000
C444
10
R442
100
C441
1500
R444
3300
MAX MIN
COUPLING
R447
10
L409
L410
R473
4700
C439
25
152-174 MC
FINAL
GRID 1
Z407
L413
L414
C454
26
L415
C453
12
C455
8
ANTENNA RELAY
K401
J411
J412
P402
P403
TO REC
A1
P401
TO ANT
A2
P401
L408
1.5 UH
C436
25
152-174 MC
DRIVER
PLATE
TUNE
C440
400
C448
10
FINAL
PLATE
TUNE
L412
C451
25
ANT
TUNE
BAL
R445
10
152-174
MC
C437
25
R441
100
C442
1500
FINAL
GRID 2
L417
C443
10
J408
C452
1000
POWER AMPL
V410
2E24
R443
3300
C449
500
R440
10K
J409
R446
10
PL CUR
J410
R449
22K
S401
TUNE
OPR
R448
47K
C435
1000
C438
1000
C445
1000
CHASSIS
C446
1000
P401
-25V
6.3V
+180V
+380V
ANTENNA
RELAY
TM 839-30

NOTES:

1. UNLESS OTHERWISE NOTED:
   ALL CAPACITOR ARE IN UUF.
   ALL RESISTORS ARE IN OHMS.
2. J406 IS USED TO METER GRID FOR TUNING.
3. K401 IS SHOWN IN ENERGIZED POSITION.

Figure 19. Radio Transmitter T-278/U, power amplifiers, simplified schematic.


C512
500
J502
FINAL GRID
L506
CHASSIS
C515
1000
J503
5TH DOUBLER AND DRIVER
V501
2E26
R508
10
MAX. MIN. COUPLING
Z407
ANTENNA RELAY
K401
POWER AMPL
V502
5894A
C514
10
L507
L413
L414
J411
TO REC
C505
1500
C517
25
FINAL PLATE TUNE
C454
26
A1
P501
TO ANT
C513
500
ANT TUNE
R507
10
BAL
C453
12
L415
J412
A2
P501
L508
C455
8
J504
C516
1000
J505
R503
47K
C523
1500
C508
25
152-174MC
FINAL GRID 1
R509
10
PL CUR
L502
L504
J506
L505
1.5UH
C511
1500
L503
1.5UH
152-174MC
C510
1500
C509
25
FINAL GRID 1
C507
25
C506
1500
DRIVER PLATE TUNE
R504
3300
OPR
TUNE
R506
2200
S502
R505
1500
C521
1000
C520
1000
C519
1000
C518
1000
3
4
5
6
P501
+225V
-25V
+6.3V
P501
+450V
+2V
29

NOTES:

1. UNLESS OTHERWISE NOTED:
   ALL CAPACITORS ARE IN UUF.
   ALL RESISTORS ARE IN OHMS.
2. J502 IS USED TO METER
   GRID FOR TUNING.

TM 839-23

Figure 20. Radio Transmitter T-416/GR, power amplifier, simplified schematic.

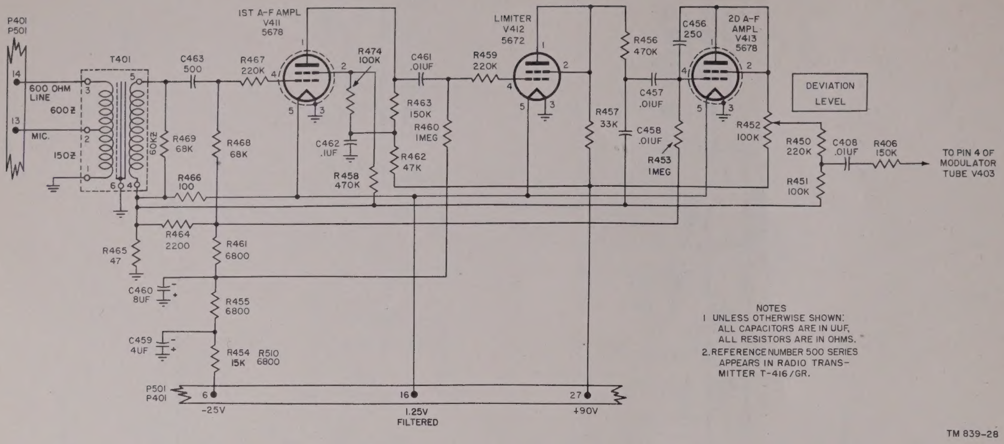

P401
P501
14
13
T401
600 OHM LINE
600Ƶ
MIC.
150Ƶ
60KƵ
C463 500
R467 220K
IST A-F AMPL V411 5678
R474 100K
C461 .01UF
R459 220K
LIMITER V412 5672
R456 470K
C456 250
2D A-F AMPL V413 5678
DEVIATION LEVEL
R469 68K
R468 68K
R466 100
C462 .1UF
R458 470K
R463 150K
R460 1MEG
R462 47K
C457 .01UF
R457 33K
C458 .01UF
R453 1MEG
R452 100K
R450 220K
C408 .01UF
R406 150K
TO PIN 4 OF MODULATOR TUBE V403
R451 100K
R464 2200
R465 47
R461 6800
C460 8UF
R455 6800
C459 4UF
R454 15K
R510 6800
P501
P401
6
16
27
-25V
1.25V FILTERED
+90V
NOTES
1 UNLESS OTHERWISE SHOWN: ALL CAPACITORS ARE IN UUF, ALL RESISTORS ARE IN OHMS.
2. REFERENCE NUMBER 500 SERIES APPEARS IN RADIO TRANSMITTER T-416/GR.
TM 839-28

Figure 21. Radio Transmitters T-278/U and T-416/GR audio stages, simplified schematic.

49. First Audio Amplifier
(fig. 21)

Microphone input is applied from terminal 13 of plug P401 (P501) to 150-ohm impedance terminal 2 of matching transformer T401. Resistor R469 serves as an impedance balance shunt across the secondary. Audio signals pass from the secondary of transformer T401 through a high-pass R-C (resistance-capacitance) network made up of capacitor C463 and resistor R468, and through resistor R467 to the control grid of tube V411. A bias voltage is fed to the grid from terminal 6 of P401 or P501 through resistors R454, R455, R461, R468, and R467. Protection against excessively high audio input is provided by resistor R467. Plate voltage is applied from terminal 27 through voltage-dropping resistor R463 and the decoupling network of R462 bypassed by capacitor C462. Resistor R458 forms a voltage divider network across the plate supply, from which screen voltage is applied through voltage-dropping resistor R474. Resistors R465 and R466 provide a hum-bucking network by providing a grid circuit return to the filament. Blocking capacitor C461 couples the output of the first amplifier to the following limiter stage through limiting resistor R459.

50. Limiter
(fig. 21)

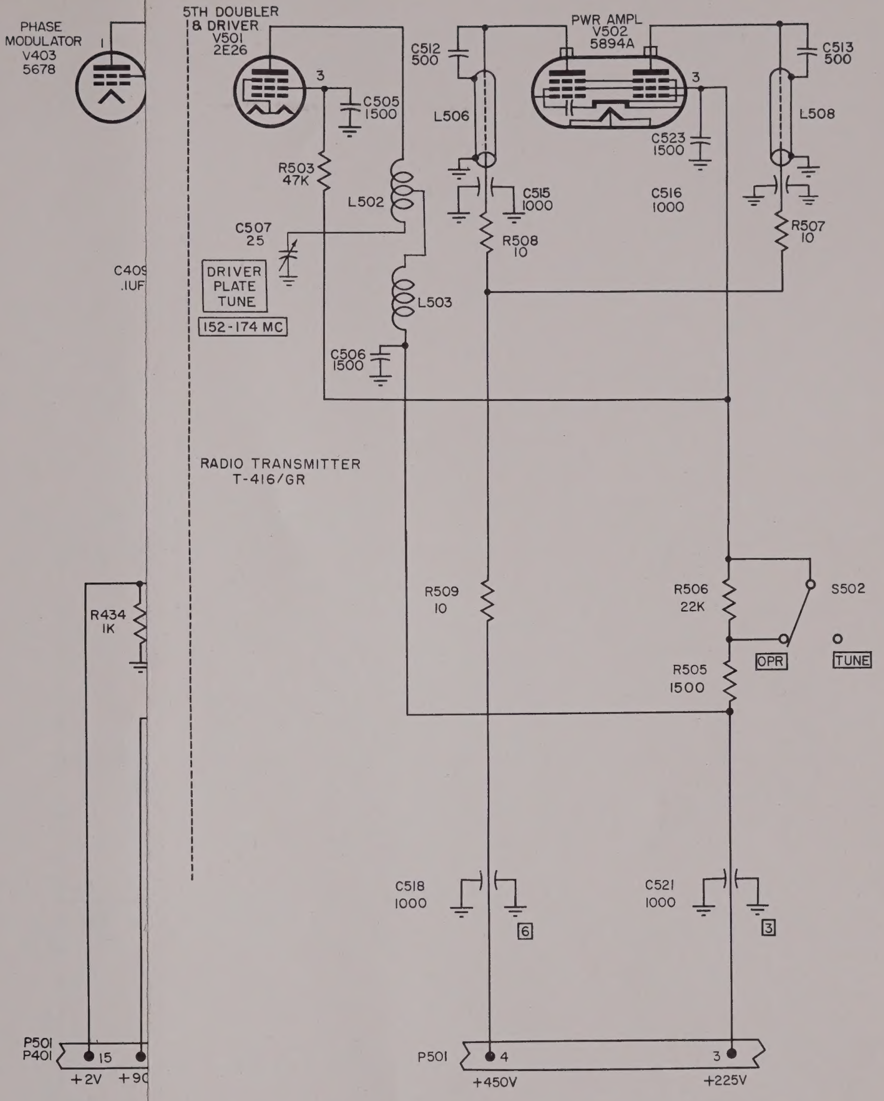
Amplified audio signals coupled through capacitor C461 are impressed on the control grid of limiter tube V412 through limiting resistor R459. Grid bias voltage is fed from terminal 6 of P401 or P501 through R454 and R455 to resistor R459 through voltage-dropping resistor R460. Plate and screen voltage is applied from terminal 27 of P401 and P501 through voltage-dropping resistor R457. The limiter output is applied to a wave-shaping network composed of low-pass R-C filter R456 and capacitor C458. Coupling to the grid of tube V413 is made through blocking capacitor C457.

51. Second Audio Amplifier
(fig. 21)

Tube V413 is the final audio amplifier and is used to drive phase modulator tube V403. R453 is the bias voltage-dropping resistor. The plate and screen of tube V413 receive operating voltage through plate load resistor R452. The variable tap of resistor R452 is used as an adjustment of the audio level to be applied to the phase modulator. This adjustment controls the DEVIATION LEVEL. Resistor R450 aids in the fine tuning of the control by introducing additional resistance. The audio output voltage is applied to the phase modulator stage through blocking capacitor C408 and resistor R406. Resistor R451 connects to the filament (R465 and R466) to provide hum-bucking action. The plate of tube V413 is connected to the control grid by capacitor C456 to provide inverse feedback.

52. B+ Distribution
(fig. 22)

a. Figure 22 shows the B+ distribution in Radio Transmitters T-278/U and T-416/GR. TUNE-OPR switch S401 in the TUNE position places resistor R448 in series with the normal screen voltage-dropping resistors R438, R444, and R443. This condition limits the plate current of the driver and power-amplifier stages to a value that will not


PHASE MODULATOR
V403
5678
1
5TH DOUBLER & DRIVER
V501
2E26
3
C505
1500
R503
47K
L502
C507
25
DRIVER PLATE TUNE
152-174 MC
L503
C506
1500
C409
.IUF
R434
1K
RADIO TRANSMITTER
T-416/GR
PWR AMPL
V502
5894A
3
C512
500
C513
500
L506
L508
C523
1500
C515
1000
C516
1000
R508
10
R507
10
R509
10
R506
22K
R505
1500
S502
OPR
TUNE
C518
1000
6
C521
1000
3
P501
P401
15
+2V
+9
P501
4
3
+450V
+225V

NOTES:

1. UNLESS OTHERWISE SHOWN; RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. REFERENCE NUMBERS OF THE 400 SERIES ARE LOCATED ON RADIO TRANSMITTER T-278/U.
3. REFERENCE NUMBERS OF THE 500 SERIES ARE LOCATED ON RADIO TRANSMITTER T-416/GR

TM 839-34

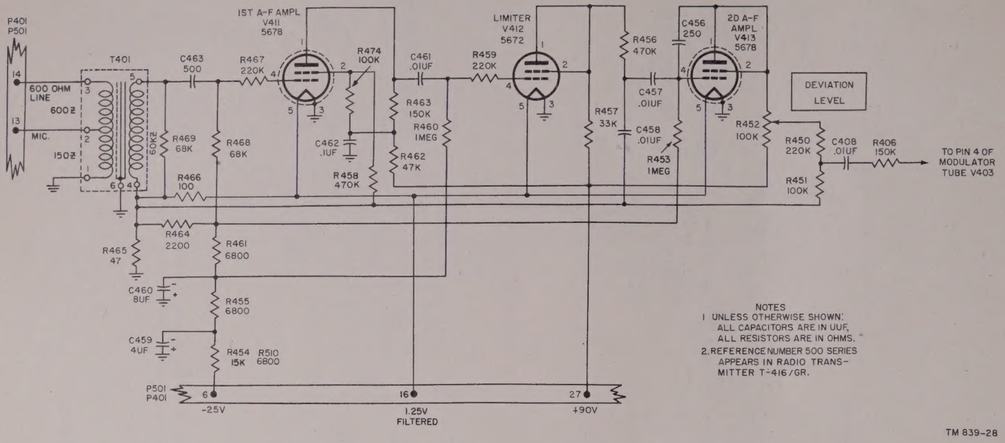

P401
P501
14
13
600 OHM LINE
600Z
MIC.
150Z
T401
60KZ
C463
500
R467
220K
IST A-F AMPL
V411
5678
R474
100K
C461
.01UF
R459
220K
LIMITER
V412
5672
R456
470K
C456
250
2D A-F AMPL
V413
5678
DEVIATION LEVEL
R469
68K
R468
68K
R466
100
C462
.1UF
R458
470K
R463
150K
R460
1MEG
R462
47K
R457
33K
C457
.01UF
C458
.01UF
R453
1MEG
R452
100K
R450
220K
C408
.01UF
R406
150K
TO PIN 4 OF MODULATOR TUBE V403
R451
100K
R464
2200
R465
47
R461
6800
C460
8UF
R455
6800
C459
4UF
R454
15K
R510
6800
P501
P401
-25V
1.25V FILTERED
+90V
NOTES
1 UNLESS OTHERWISE SHOWN: ALL CAPACITORS ARE IN UUF, ALL RESISTORS ARE IN OHMS.
2. REFERENCE NUMBER 500 SERIES APPEARS IN RADIO TRANSMITTER T-416/GR.
TM 839-28

Figure 21. Radio Transmitters T-278/U and T-416/GR audio stages, simplified schematic.

49. First Audio Amplifier
(fig. 21)

Microphone input is applied from terminal 13 of plug P401 (P501) to 150-ohm impedance terminal 2 of matching transformer T401. Resistor R469 serves as an impedance balance shunt across the secondary. Audio signals pass from the secondary of transformer T401 through a high-pass R-C (resistance-capacitance) network made up of capacitor C463 and resistor R468, and through resistor R467 to the control grid of tube V411. A bias voltage is fed to the grid from terminal 6 of P401 or P501 through resistors R454, R455, R461, R468, and R467. Protection against excessively high audio input is provided by resistor R467. Plate voltage is applied from terminal 27 through voltage-dropping resistor R463 and the decoupling network of R462 bypassed by capacitor C462. Resistor R458 forms a voltage divider network across the plate supply, from which screen voltage is applied through voltage-dropping resistor R474. Resistors R465 and R466 provide a hum-bucking network by providing a grid circuit return to the filament. Blocking capacitor C461 couples the output of the first amplifier to the following limiter stage through limiting resistor R459.

50. Limiter
(fig. 21)

Amplified audio signals coupled through capacitor C461 are impressed on the control grid of limiter tube V412 through limiting resistor R459. Grid bias voltage is fed from terminal 6 of P401 or P501 through R454 and R455 to resistor R459 through voltage-dropping resistor R460. Plate and screen voltage is applied from terminal 27 of P401 and P501 through voltage-dropping resistor R457. The limiter output is applied to a wave-shaping network composed of low-pass R-C filter R456 and capacitor C458. Coupling to the grid of tube V413 is made through blocking capacitor C457.

51. Second Audio Amplifier
(fig. 21)

Tube V413 is the final audio amplifier and is used to drive phase modulator tube V403. R453 is the bias voltage-dropping resistor. The plate and screen of tube V413 receive operating voltage through plate load resistor R452. The variable tap of resistor R452 is used as an adjustment of the audio level to be applied to the phase modulator. This adjustment controls the DEVIATION LEVEL. Resistor R450 aids in the fine tuning of the control by introducing additional resistance. The audio output voltage is applied to the phase modulator stage through blocking capacitor C408 and resistor R406. Resistor R451 connects to the filament (R465 and R466) to provide hum-bucking action. The plate of tube V413 is connected to the control grid by capacitor C456 to provide inverse feedback.

52. B+ Distribution
(fig. 22)

a. Figure 22 shows the B+ distribution in Radio Transmitters T-278/U and T-416/GR. TUNE-OPR switch S401 in the TUNE position places resistor R448 in series with the normal screen voltage-dropping resistors R438, R444, and R443. This condition limits the plate current of the driver and power-amplifier stages to a value that will not

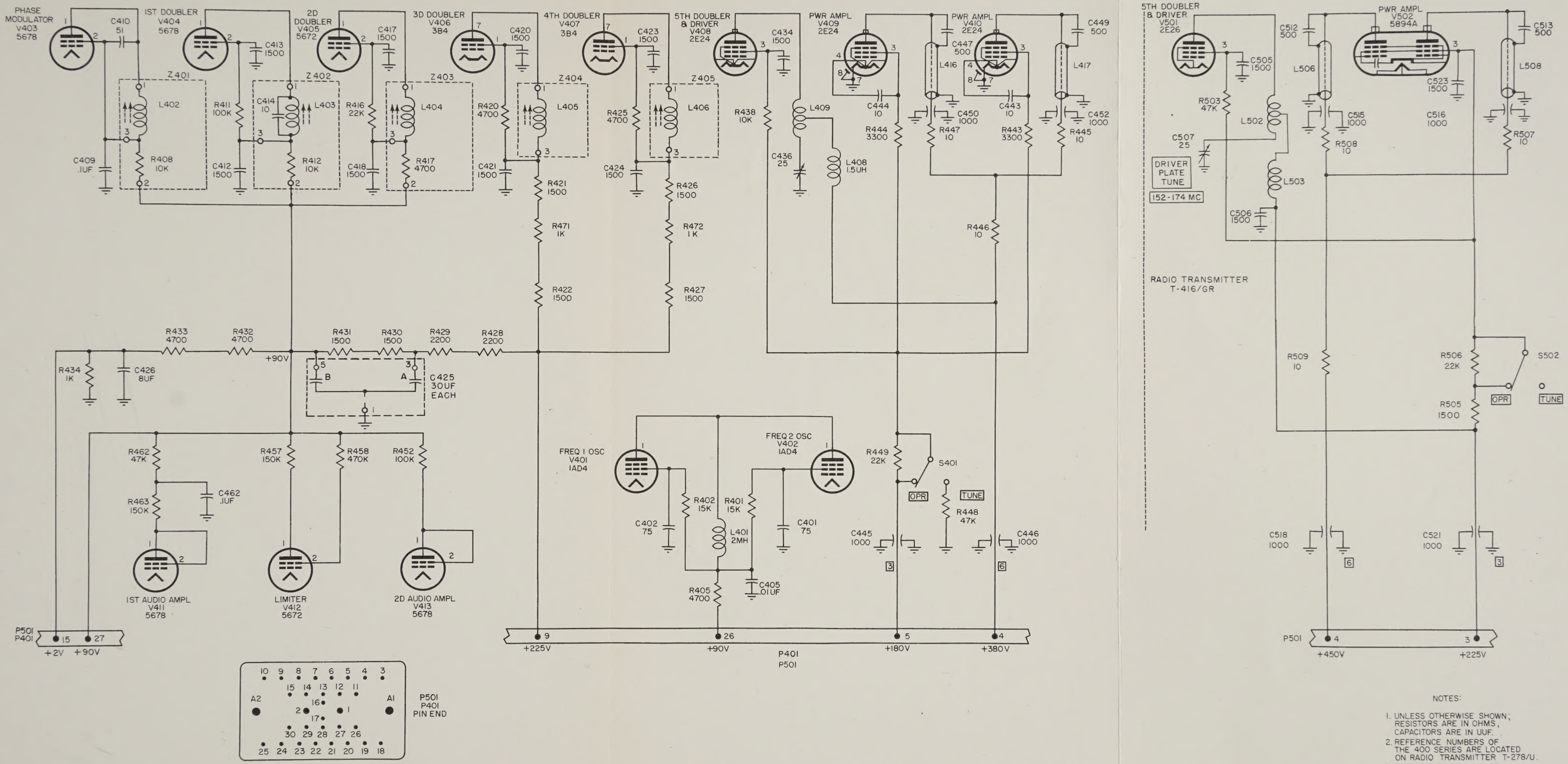

PHASE MODULATOR V403 5678
C410 51
IST DOUBLER V404 5678
C413 1500
Z401
L402
R411 100K
R408 10K
C409 .1UF
C412 1500
2D DOUBLER V405 5672
C417 1500
Z402
C414 10
L403
R416 22K
R412 10K
C418 1500
3D DOUBLER V406 3B4
C420 1500
Z403
L404
R417 4700
R420 4700
C421 1500
4TH DOUBLER V407 3B4
C423 1500
Z404
L405
R425 4700
C424 1500
R421 1500
R471 1K
R422 1500
5TH DOUBLER & DRIVER V408 2E24
C434 1500
Z405
L406
R426 1500
R472 1K
R427 1500
R438 10K
L409
C436 25
L408 1.5UH
PWR AMPL V409 2E24
C444 10
R444 3300
L416
C450 1000
R447 10
PWR AMPL V410 2E24
C447 500
C443 10
R443 3300
C449 500
L417
C452 1000
R445 10
R446 10
R433 4700
R432 4700
R431 1500
R430 1500
R429 2200
R428 2200
+90V
R434 1K
C426 8UF
C425 30UF EACH
A
B
R462 47K
R463 150K
C462 .1UF
R457 150K
R458 470K
R452 100K
IST AUDIO AMPL V411 5678
LIMITER V412 5672
2D AUDIO AMPL V413 5678
FREQ 1 OSC V401 1AD4
FREQ 2 OSC V402 1AD4
C402 75
R402 15K
R401 15K
L401 2MH
C401 75
C405 .01UF
R405 4700
R449 22K
S401
OPR
TUNE
R448 47K
C445 1000
C446 1000
P501 P401
15
27
+2V
+90V
9
+225V
26
+90V
5
+180V
4
+380V
P401 P501
10 9 8 7 6 5 4 3
15 14 13 12 11
16
A2
A1
2 1
17
30 29 28 27 26
25 24 23 22 21 20 19 18
P501 P401 PIN END
5TH DOUBLER & DRIVER V501 2E26
C505 1500
R503 47K
L502
C507 25
DRIVER PLATE TUNE
152-174 MC
L503
C506 1500
C512 500
L506
C515 1000
R508 10
PWR AMPL V502 5894A
C523 1500
C516 1000
C513 500
L508
R507 10
RADIO TRANSMITTER T-416/GR
R509 10
R506 22K
S502
OPR
TUNE
R505 1500
C518 1000
C521 1000
P501
4
+450V
3
+225V
TM 839-34

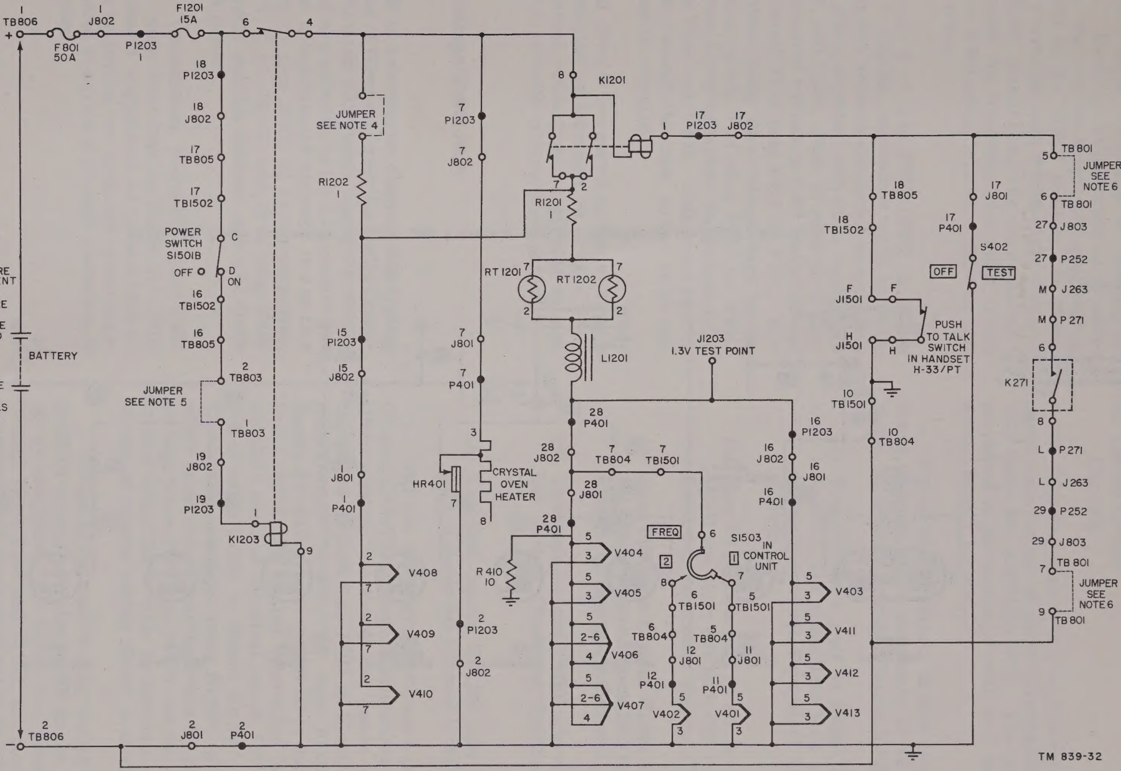
Figure 22. Radio Transmitters T-278/U and T-416/GR B+ distribution, simplified schematic.

NOTES:

1. UNLESS OTHERWISE SHOWN; RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. REFERENCE NUMBERS OF THE 400 SERIES ARE LOCATED ON RADIO TRANSMITTER T-278/U.
3. REFERENCE NUMBERS OF THE 500 SERIES ARE LOCATED ON RADIO TRANSMITTER T-416/GR

NOTES:

1. ALL RESISTORS ARE IN OHMS.
2. TERMINALS OF THE 400 SERIES ARE LOCATED IN RADIO TRANSMITTER T-278/U.
   TERMINALS OF THE 800 SERIES ARE LOCATED IN ELECTRICAL EQUIPMENT CABINET CY-938/U.
   TERMINALS OF THE 1200 SERIES ARE LOCATED IN DYNAMOTOR POWER SUPPLY DY-100/U TERMINALS OF THE 1500 SERIES ARE LOCATED IN RADIO SET CONTROL C-847/U.
3. ALL SWITCHES AND RELAYS SHOWN IN ENERGIZED POSITION.
4. JUMPER USED WHEN IT IS DESIRABLE TO LEAVE FILAMENTS IN STAND-BY.
5. JUMPER SHOWN BETWEEN TERMINALS USED WHEN 6-V OR 12-VDC POWER IS SUPPLIED.
6. JUMPER USED TO ENERGIZE TRANSMITTER WITH RECEIVE SQUELCH.


1 TB806
F801 50A
1 J802
P1203 1
F1201 15A
6
4
18 P1203
18 J802
17 TB805
17 TB1502
POWER SWITCH S1501B
C
OFF
D ON
16 TB1502
16 TB805
2 TB803
JUMPER SEE NOTE 5
1 TB803
19 J802
19 P1203
K1203
1
9
BATTERY
2 TB806
2 J801
2 P401
JUMPER SEE NOTE 4
R1202 1
15 P1203
15 J802
1 J801
1 P401
V408
V409
V410
7 P1203
7 J802
7 J801
7 P401
HR401
CRYSTAL OVEN HEATER
3
8
2 P1203
2 J802
R410 10
8
K1201
R1201 1
RT1201
RT1202
L1201
28 P401
28 J802
28 J801
7 TB804
7 TB1501
V404
V405
V406
V407
2-6
J1203 1.3V TEST POINT
FREQ
S1503 IN CONTROL UNIT
6 TB1501
6 TB804
12 J801
12 P401
5 TB1501
5 TB804
11 J801
11 P401
V402
V401
16 P1203
16 J802
16 J801
16 P401
V403
V411
V412
V413
17 P1203
17 J802
18 TB805
18 TB1502
F J1501
H J1501
PUSH TO TALK SWITCH IN HANDSET H-33/PT
10 TB1501
10 TB804
17 J801
17 P401
S402
OFF
TEST
TB801
JUMPER SEE NOTE 6
27 J803
27 P252
M J263
M P271
K271
L P271
L J263
29 P252
29 J803
TB801

TM 839-32

Figure 23. Radio Transmitter T-278/U, filament voltage distribution, simplified schematic.

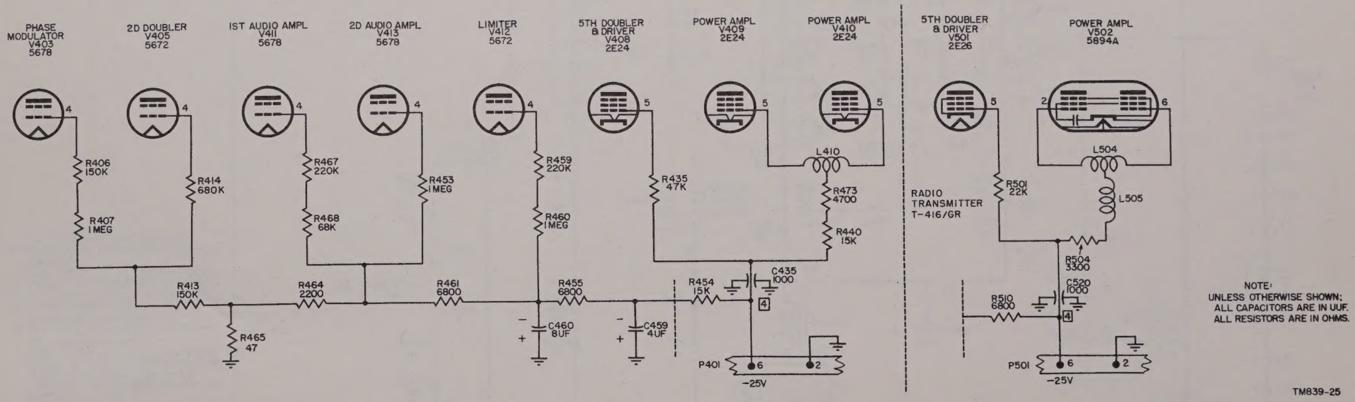

PHASE MODULATOR V403 5678
2D DOUBLER V405 5672
IST AUDIO AMPL V411 5678
2D AUDIO AMPL V413 5678
LIMITER V412 5672
5TH DOUBLER & DRIVER V408 2E24
POWER AMPL V409 2E24
POWER AMPL V410 2E24
5TH DOUBLER & DRIVER V501 2E26
POWER AMPL V502 5894A
R406 150K
R407 1MEG
R414 680K
R467 220K
R468 68K
R453 1MEG
R459 220K
R460 1MEG
R435 47K
L410
R473 4700
R440 15K
R413 150K
R465 47
R464 2200
R461 6800
R455 6800
C460 8UF
C459 4UF
R454 15K
C435 1000
4
P401
6
2
−25V
RADIO TRANSMITTER T-416/GR
R501 22K
L504
L505
R504 3300
C520 1000
R510 6800
P501
NOTE:
UNLESS OTHERWISE SHOWN;
ALL CAPACITORS ARE IN UUF.
ALL RESISTORS ARE IN OHMS.
TM839-25

Figure 24. Radio Transmitters T-278/U and T-416/GR grid bias distribution, simplified schematic.

harm the tubes under conditions of detuning or misadjustment. Resistor R448 serves as an additional load for the screen supply when operating with switch S401 in the TUNE position. In Radio Transmitter T-416/GR with TUNE-OPR switch S502 in the TUNE position, the screen potential is dropped by removing the short from across resistor R506 which places it in series with resistor R505.

b. Terminal 9 of plug P401 (P501 in Radio Transmitter T-416/GR) introduces +225 volts dc to a voltage divider network consisting of resistors R428 through R434, together with filter capacitors C425A, C425B, and C426. Plus 90 volts dc is tapped at the junction of resistors R431 and R432 and brought to terminal 27 of plug P401 or P501. External connections bring the voltage back to the transmitter at terminal 26 of plug P401 or P501, from which point it provides plate and screen voltages for tubes V401 and V402. This voltage is also connected, through the case, to the radio receiver for squelch operation.

c. The final +2-volt d-c output at the voltage divider is connected to terminal 15 of plug P401 or P501. External connections supply this voltage to the handset to provide microphone current.

53. Filament Voltage Distribution

(fig. 23)

a. Figure 23 is a schematic diagram illustrating the distribution of filament power for Radio Transmitter T-278/U used with Power Supply PP-640/U. Controls which are external to the transmitter (par. 55) allow completion of circuits from the system battery to plug P401 of the transmitter. Terminals 1, 7, 8, 11, 12, 16, and 28 of plug P401 supply the crystal heating element and all tube filaments with power.

b. In Radio Transmitter T-416/GR, plug P501 completes the same functions as listed for P401 above. Terminal 1 supplies a single power-amplifier tube instead of two separate power amplifiers. Terminal 8 allows 24-volt operation of the crystal heater.

54. Grid Bias Distribution

(fig. 24)

Figure 24 illustrates grid bias distribution for Radio Transmitters T-278/U and T-416/GR. Grid bias voltage is supplied from a dynamotor output in an external power supply to terminal 6 of plug P401 and P501. A voltage divider and filter network in the transmitter distributes correct bias voltage to the tubes.

55. Control Circuits

(fig. 25)

The following description of control circuits is based upon the use of Radio Transmitter T-278/U with Radio Set AN/VRC-19(*). The power supply employed is the mobile, 6-volt, d-c, powered unit, Power Supply PP-640/U.

a. The extensive system of interconnection between units makes it necessary to identify the plugs, jacks, and terminal boards involved.

(1) Plug P401 is a part of Radio Transmitter T-278/U and plugs into jack J801 located inside Electrical Equipment Cabinet CY-938/VRC.

(2) Plug P1203 is a part of Power Supply PP-640/U and plugs into jack J802 located inside Electrical Equipment Cabinet CY-938/VRC.

(3) Plug P252 is a part of Radio Receiver R-394/U and plugs into jack J803 located inside Electrical Equipment Cabinet CY-938/VRC.

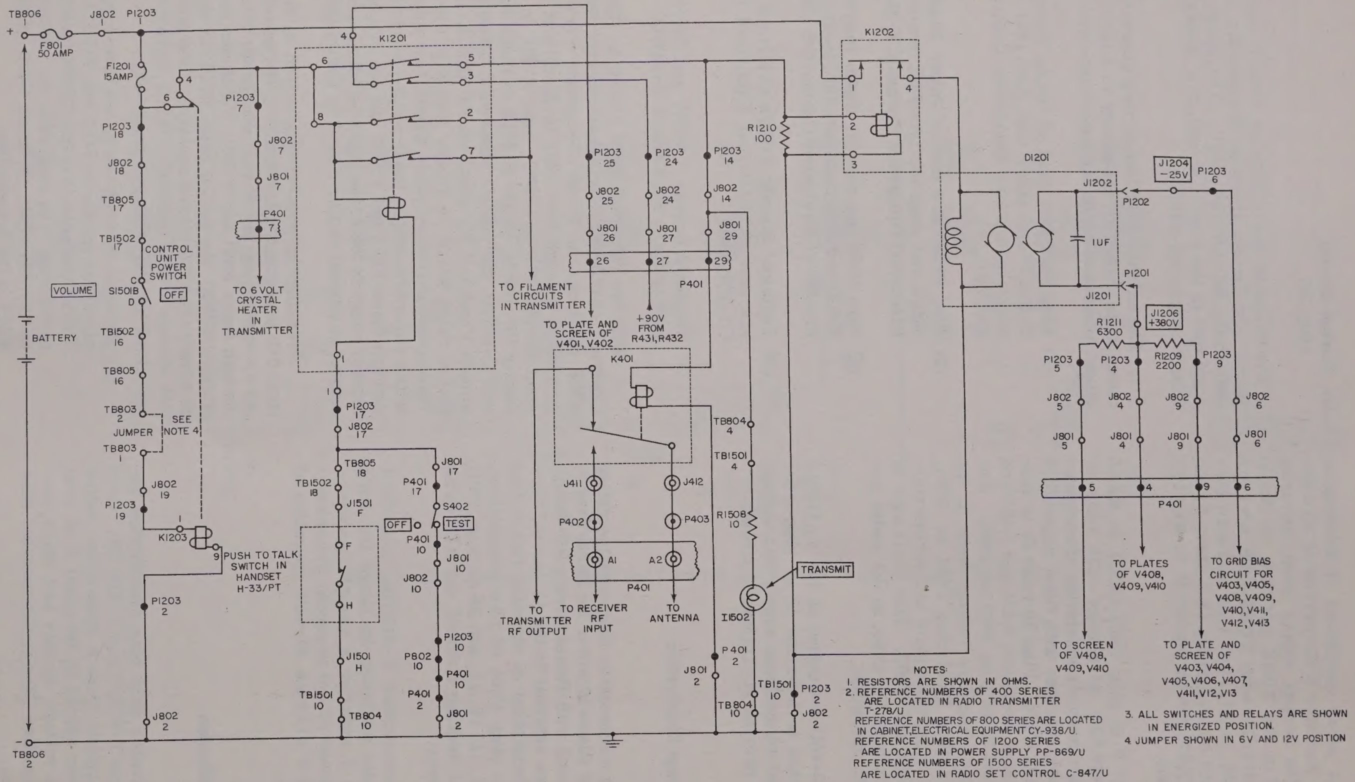
(4) Terminal Boards TB801 through TB806 are part of Electrical Equipment Cabinet CY-938/VRC.

(5) Terminal boards TB1501 and TB1502 are part of Radio Set Control C-847/U.

b. With the VOLUME-OFF switch on Radio Set Control C-847/U turned clockwise toward the VOLUME position, the 6-volt d-c power circuit is completed through fuse F801 in Electrical Equipment Cabinet CY-938/VRC, fuse F1201 in Power Supply PP-640/U, switch S1501B in Radio Set Control C-847/U, the jumper connection between terminals 1 and 2 of terminal board TB803, and the coil of relay K1203 in Power Supply PP-640/U. This action energizes relay K1203, two contacts of which close to complete the 6-volt d-c power circuit through fuses F801 and F1201 and the closed contacts of relay K1203 to the heater element and thermostat of crystal heater HR401 in the transmitter.

c. Pressing the push-to-talk switch on Handset H-33/PT energizes relay K1201 in the power supply by completing the 6-volt d-c power circuit through fuses F801 and F1201, the closed contacts of relay K1203, the coil of relay K1201 in the power supply, and the closed contacts of the press-to-talk switch of the handset. With relay K1201 energized the following action occurs:

(1) Six volts dc from the power source is supplied through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to terminal 1 of plug P401 for distribution to the filaments of tubes V408, V409 and V410 in the transmitter.


TB806 1
+
F801 50 AMP
J802 1
P1203 1
F1201 15AMP
P1203 18
J802 18
TB805 17
TB1502 17
CONTROL UNIT POWER SWITCH
C
S1501B
D
OFF
VOLUME
BATTERY
TB1502 16
TB805 16
TB803 2
JUMPER
SEE NOTE 4
TB803 1
J802 19
P1203 19
K1203
PUSH TO TALK SWITCH IN HANDSET H-33/PT
P1203 2
J802 2
TB806 2
P1203 7
J802 7
J801 7
P401
TO 6 VOLT CRYSTAL HEATER IN TRANSMITTER
K1201
TO FILAMENT CIRCUITS IN TRANSMITTER
P1203 17
J802 17
TB805 18
TB1502 18
J1501 F
J1501 H
TB1501 10
TB804 10
J801 17
P401 17
S402
OFF
TEST
P401 10
J801 10
J802 10
P1203 10
P802 10
P401 10
P401 2
J801 2
P1203 25
J802 25
J801 26
P1203 24
J802 24
J801 27
P1203 14
J802 14
J801 29
P401
TO PLATE AND SCREEN OF V401, V402
+90V FROM R431, R432
K401
J411
J412
P402
P403
A1
A2
TO TRANSMITTER RF OUTPUT
TO RECEIVER RF INPUT
TO ANTENNA
TB804 4
TB1501 4
R1508 10
TRANSMIT
I1502
P401 2
J801 2
TB1501 10
TB804 10
P1203 2
J802 2
R1210 100
K1202
D1201
J1202
P1202
J1204 −25V
P1203 6
1UF
J1201
P1201
J1206 +380V
R1211 6300
R1209 2200
P1203 5
P1203 4
P1203 9
J802 5
J802 4
J802 9
J802 6
J801 5
J801 4
J801 9
J801 6
P401
TO SCREEN OF V408, V409, V410
TO PLATES OF V408, V409, V410
TO PLATE AND SCREEN OF V403, V404, V405, V406, V407, V411, V12, V13
TO GRID BIAS CIRCUIT FOR V403, V405, V408, V409, V410, V411, V412, V413
TM 839-35

NOTES:

1. RESISTORS ARE SHOWN IN OHMS.
2. REFERENCE NUMBERS OF 400 SERIES ARE LOCATED IN RADIO TRANSMITTER T-278/U
REFERENCE NUMBERS OF 800 SERIES ARE LOCATED IN CABINET, ELECTRICAL EQUIPMENT CY-938/U.
REFERENCE NUMBERS OF 1200 SERIES ARE LOCATED IN POWER SUPPLY PP-869/U
REFERENCE NUMBERS OF 1500 SERIES ARE LOCATED IN RADIO SET CONTROL C-847/U
3. ALL SWITCHES AND RELAYS ARE SHOWN IN ENERGIZED POSITION.
4. JUMPER SHOWN IN 6V AND 12V POSITION

Figure 25. Radio Transmitter T-278/U, relay control, simplified schematic.

(2) A d-c voltage of 1.3 volts is obtained by connection of the 6-volt d-c power circuit through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to the voltage-dropping and regulating circuit in the power supply composed of resistor R1201, R1202, RT1201 and RT1202 and inductance L1201. The circuit then is completed to terminals 16 and 28 of plug P401 for distribution to the filaments of tubes V403 through V407 and V411, through V413 in the transmitter.

(3) The 1.3-volt d-c supply is tapped in the case and sent through the FREQ selector switch S1503 in the radio set control to terminal 11 or 12 of plug P401 for distribution to tubes V401 and V402 in the transmitter. The radio set control switch determines which tube receives filament voltage.

(4) Six volts dc is supplied from the power source through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to the coil of relay K401 in the transmitter at terminal 29 of plug P401. This action energizes relay K401, thereby connecting the r-f power output of the transmitter to the antenna. The TRANSMIT indicator lamp in the radio set control will light.

(5) Six volts dc is supplied from the power source through fuses F801 and F1201 and the closed contacts of relays K1203 and K1201 to the coil of relay K1202, thereby energizing the relay.

d. With relay K1202 energized, 6 volts dc from the power source is supplied through fuse F801 and the closed contacts of relay K1202 to dynamotor D1201 in the power supply. The dynamotor operates and supplies power to the following circuits:

(1) Minus 25 volts dc is supplied to terminal 6 of plug P401 in the transmitter for application to a filter and voltage divider network which proportions the bias voltage to tubes V403, V405, and V408 through V413. Figure 24 is a schematic diagram of grid bias distribution.

(2) Plus 225 volts dc is supplied to terminal 9 of plug P401 in the transmitter to provide plate and screen voltage to tubes V406 and V407. A filter and voltage divider network also receives the +225-volt input. Plus 90 volts dc from the divider is supplied to the plate and screen circuits of tubes V403, V404, V405, V411, V412, and V413. This +90 volts also is connected to terminal 27 of plug P401 in the transmitter. From this point the circuit is completed externally through the closed contacts of relay K1201 in the power supply and back to the transmitter at terminal 26 of plug P401. This terminal supplies plate and screen voltages to tubes V401 and V402. Connection within Electrical Equipment Cabinet CY-938/VRC brings this same +90 volts to the radio receiver for squelch operation. Plus 2 volts dc also is supplied by the divider network to terminal 15 of plug P401 to provide voltage for voice operation of the handset. Audio-frequency voltages developed in the handset are supplied to modulation transformer T401 of the transmitter by connection to terminal 13 of plug P401. The grounded terminal of transformer T401 completes the circuit.

(3) Plus 380 volts d-c is supplied to terminal 4 of plug P401 in the transmitter for application of plate voltage to tubes V408, V409, and V410.

(4) A d-c voltage of 180 volts is supplied to terminal 5 of plug P401 in the transmitter to provide screen voltage to tubes V408, V409, and V410.

e. All the control circuits described above were set into action by the operation of two switches: the VOLUME-OFF switch at Radio Set Control C-847/U and the push-to-talk switch of Handset H-33/PT. During the initial tuning procedure, TEST-OFF switch S402 in the transmitter is used instead of the push-to-talk switch of the handset. Switch S402 parallels the handset and energizes relay K1201 in the power supply in the same manner as did the handset switch. The circuit is from the 6-volt d-c source through fuses F801 and F1201, the closed contacts of relay K1203, the coil of K1201, and switch S402 of the transmitter in the TEST position to ground. Power thus is applied to the transmitter in the same sequence as described for handset operation.

f. In Radio Transmitter T-416/GR plug P501 is the connection point for power and control circuits to the transmitter from external sources. Each terminal corresponds to the same terminal on plug P401 of Radio Transmitter T-278/U and serves the same circuits, with the following exceptions:

(1) Terminal 5 of plug P501 is not used. Terminal 3 is used instead to supply +225 volts d-c to the plate and screen circuit of tube V501 and to the screen circuit of tube V502.

(2) Plus 450 volts d-c is supplied at terminal 4 instead of +380 volts.

56. Retransmission Circuits

An adaptation of push-to-talk operation is retransmission. This allows the transmitter to function as a relay station to extend the range of another transmitter, or to provide a link between two sets whose difference in frequency ranges make communication otherwise impossible. In this application, the handset input is replaced by the signal received from a distant transmitter by the radio receiver.

a. For retransmission operation the transmitter power is applied by turning the VOLUME-OFF switch in Radio Set Control C-847/U toward the VOLUME position. Jumper connections in Electrical Equipment Cabinet CY-938/VRC energize relay K1201 in Power Supply PP-640/U. The circuit is through the 6-volt d-c power source, fuses F801 and F1201, the closed contacts of relay K1203, the winding of relay K1201, a jumper between terminals 5 and 6 of terminal board TB-801 in the case, the closed contacts of relay K271 in Radio Receiver R-394/U, and a jumper between terminals 7 and 9 of terminal board TB801 in the case, to ground. The jumper between terminals 3 and 4 of terminal board TB801 is removed to prevent muting the receiver. Under these conditions, receiver relay K271 is energized whenever audio output is present, and completes the circuit for application of power to the transmitter.

b. The audio output of the radio receiver, which is the signal to be retransmitted, is fed to the transmitter at terminal 14 of plug P401. This is a 600-ohm line input connected to terminal 3 of modulation transformer T401, and then through the entire transformer winding to terminal 1, which is grounded.

c. The transmitter now is modulated by a received audio signal. Transmission is completed as explained in the theory section. An additional antenna is necessary to serve the receiver, as are various jumper arrangements in the case. Refer to the system instruction book for retransmission.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Section I. TROUBLE SHOOTING AT FIELD MAINTENANCE LEVEL

Warning: When servicing Radio Transmitters T-278/U and T-416/GR be careful because of the high d-c voltage in the power-amplifier stage. Always disconnect the patch cord before making resistance checks.

57. Trouble-shooting Procedures

The first step in servicing a defective radio set is to sectionalize the fault. Sectionalization means tracing the fault to the major component or circuit responsible for the abnormal operation of the set. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults such as burned-out resistors, r-f arcing, and shorted transformers often can be located by sight, smell, or hearing. The majority of faults, however, must be localized by checking voltage and resistance.

a. System Sectionalization. System sectionalization is discussed in the system instruction book for the particular radio set used.

b. Component Sectionalization and Localization. The tests listed below aid in isolating the source of trouble. To be effective the procedure should be followed in the order given. First, trouble should be localized to a single stage or circuit. Then the trouble may be isolated within that stage or circuit by appropriate voltage, resistance, and continuity measurements. The service procedure is summarized as follows:

(1) *Visual inspection.* The purpose of visual inspection (par. 40) is to locate any visible trouble. Through this inspection alone, the repairman frequently may discover the trouble, or determine the stage in which the trouble exists. This inspection is valuable in avoiding additional damage to the transmitter which might occur through improper servicing methods and in forestalling future failures.

(2) *Resistance measurements.* These measurements (par. 61) may prevent further damage to the units from possible short circuits caused by faulty components.

(3) *Operational test.* The operational test (par. 62) is important because it frequently indicates the general location of trouble.

(4) *Trouble-shooting chart.* The trouble symptoms listed in these charts (par. 63) will aid greatly in localizing trouble.

(5) *Intermittents.* In all these tests, the possibility of intermittents should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the set. Do not tap the subminiature-type tubes. It is possible that the trouble is not in the transmitter itself but in the installation (antenna, interconnections, etc.), or the trouble may be caused by external conditions; in this event, test the installation.

58. Trouble-shooting Data

Take advantage of the material supplied in this instruction book. It will help in the rapid location of faults. Consult the following trouble-shooting data:

Fig. & Par. No.	Description
Fig. 4	Radio Transmitters T-278/U and T-416/GR tube location.
Fig. 8	Radio Transmitters T-278/U and T-416/GR crystal oven HR401, disassembled view.
Fig. 9	Radio Transmitters T-278/U and T-416/GR, crystal oven HR401, exploded view.
Fig. 26	Radio Transmitter T-278/U, right side view.
Fig. 27	Radio Transmitter T-278/U, right side view.
Fig. 28	Radio Transmitter T-278/U, left side view.
Fig. 29	Radio Transmitter T-278/U, front view.
Fig. 30	Radio Transmitter T-278/U, bottom view.

58. Trouble-shooting Data (contd)

Fig. & Par. No.	Description
Fig. 31	Radio Transmitter T-416/GR, right side view.
Fig. 32	Radio Transmitter T-416/GR, left side view.
Fig. 33	Radio Transmitter T-416/GR, front view.
Fig. 34	Radio Transmitter T-416/GR, bottom view.
Fig. 35	Radio Transmitters T-278/U and T-416/GR, voltage and resistance at tube sockets.
Fig. 36	Radio Transmitters T-278/U and T-416/GR, voltage and resistance at terminal boards.
Fig. 40	Resistor color codes.
Fig. 41	Capacitor color codes.
Fig. 42	Radio Transmitter T-278/U, schematic diagram.
Fig. 43	Radio Transmitter T-416/GR, schematic diagram.
Par. 64	Transformer and coil d-c resistance chart.

59. Test Equipment Required for Trouble-shooting

The test equipment required for trouble shooting Radio Transmitters T-278/U and T-416/GR is listed below. The technical manuals associated with the test equipment are also listed.

Test equipment	Technical Manual
Multimeter TS-352/U	TM 11-5527
Tube Tester I-177, or equal	TM 11-2627
Adapter Kit MX-949	TM 11-2627-3

60. General Precautions

Whenever the transmitter is serviced, observe the following precautions:

a. Be careful when dust covers are removed; high d-c voltage is exposed.

b. Careless replacement of parts often makes new faults inevitable. Observe the following points:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer or filter, has a number of connections, tag each lead to it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not use a large soldering iron when soldering small resistors or ceramic capacitors. Overheating of the small parts may ruin or change the value of the component.

(4) Do not allow drops of solder to fall into the set since they may cause short circuits.

(5) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to locate.

(6) When a part is replaced in a vhf circuit, it must be placed in exactly the same position as the original part. A part which has the same electrical value but different physical size may cause trouble in vhf circuits. Give particular attention to proper grounding when replacing a part. Use the same ground as in the original wiring. Failure to observe these precautions may result in loss of oscillation, decreased output, or parasitic oscillations.

61. Checking B+ Circuits for Shorts

Figure 22 is a simplified diagram of the B+ distribution throughout the transmitter and the possible paths which could short circuit. By using this diagram in conjunction with the voltage and resistance measurements found in figures 35 and 36, the typical causes for trouble can be checked easily. If resistance is low, check for a shorted bypass capacitor in one of the plate or screen grid circuits, a short in the wiring in one of the plate or screen circuits, or leakage in a capacitor. If the B+ circuit is shorted in the decoupling network of one stage, it may drop the voltage so that several stages are affected. High resistance readings indicate defective resistors or an open circuit.

62. Operational Test

The operational test is used to check for the proper functioning of the transmitter. For this purpose, a dummy antenna may be used instead of the regular transmitting antenna. Operate the transmitter as described in the equipment performance checklist (par. 41). Check that all functions described in the normal indications column are completed. Listen for crackling or buzzing noises which indicate h-v (high-voltage) arcing. Check for smoke and the odor of burned or overheated parts.

63. Trouble-shooting Chart

The following chart is supplied as an aid in locating trouble in the transmitter. Transmitter operation is dependent on all system components. For this reason, trouble shooting has been extended to cover possible faults in components external to the transmitter. Once the trouble has been localized to a stage or circuit of the transmitter, a tube check and voltage and resistance measurements of this stage or circuit ordinarily should be sufficient to isolate the defective part. Normal voltage and resistance measurements are given in figures 35 and 36.

Symptom	Trouble	Correction
1. Crystal oven does not heat.	1. System battery is discharged.	1. Recharge or replace.
	Fuse F801 in Electrical Equipment Cabinet CY-938/VRC or fuse F1201 in Power Supply PP-640/U is open.	
	Switch S1501B in Radio Set Control C-847/U is defective.	Replace.
	Jumper connection between terminals 1 and 2 of terminal board TB803 in Electrical Equipment Cabinet CY-938/VRC is missing.	Connect.
	Contacts of relay K1203 in Power Supply PP-640/U are not closing.	Repair and adjust.
	Defective plugs, jacks, or terminal boards (P401, P1203, J801, J802, TB-803, TB805, TB806, TB-1502).	Repair.
	Defective cable from radio Set control to case.	
	Defective heater and thermostat in the crystal oven.	Replace.
2. No filament voltage for tube V401 or V402.	2. Power Supply PP-640/U is not energized.	2. Refer to first seven items in the Trouble column, under 1.
	Contacts of relay K1201 in power supply fail to close.	Repair and adjust.
	Defective terminal boards TB804 or TB1501.	Repair.
	Defective push-to-talk switch on handset.	Repair or replace handset.
	Defective tube.	Replace.

Symptom	Trouble	Correction
	Defective components in the power supply (R1201, RT1201, TR1202, L1201).	Replace.
	Defective switch S1503 in the radio set control.	Repair or replace
	Incorrect switch setting on radio set control.	Set to FREQ 1 or FREQ 2.
3. No filament voltage for tubes V403, V404, V405, V406, V407, V411, V412, V413.	3. Same as the first six items under 2.	3. Refer to first six items in the Trouble column, under 2.
4. No filament voltage for tubes V408, V409, V410.	4. Same as the first five items under 2.	4. Refer to first five items in the Trouble column, under 2.
	Shorted circuits elements.	Check filament circuits (fig. 23) and repair defect.
5. No plate or screen voltage.	5. Same as the first five items under 2.	5. Refer to first five items in the Trouble column, under 2.
	Defective dynamotor in the power supply.	Repair or replace.
	Shorted circuit elements.	Check B+ distribution (fig. 22) and repair defect.
6. No grid bias to tubes V403, V405, V408, V409, V410, V411, V412, V413.	6. Defective circuit components.	6. Refer to grid bias distribution (fig. 24) and repair defect.
7. No microphone current for handset.	7. Same as the first four items under 2.	7. Refer to first four items in the Trouble column, under 2.
	Defective components in the voltage divider network (R432, R433, R434, C426).	Replace.
	Open winding in transformer T401.	Replace.
8. Antenna relay does not operate.	8. Same as the first four items under 2.	8. Refer to first four items in the Trouble column, under 2.
	Open winding in relay coil.	Replace.
	Contacts of the relay do not operate.	Repair and adjust.

Symptom	Trouble	Correction
9. Power is not applied to transmitter in the TEST position.	9. Defective switch S402.	9. Replace.
10. Oscillator stage does not tune.	10. Defective crystal.	10. Replace.
	Open or shorted bypass capacitor or tuning capacitor.	Replace.
	Defective tube V401 or V402.	Replace.
11. One of the stages (V403, V404, V405, V406, V407, V408, V409) fails to tune.	11. Defective tube.	11. Replace.
	No drive from the previous stage.	Retune previous stage.
	Open or shorted bypass capacitor, tuning capacitor, or coupling capacitor.	Repair or replace.
	Open or shorted resistors.	Replace.
	Defective r-f coils in the preceding stage.	Replace.
12. No r-f output from transmitter.	12. Defective ANT. TUNE capacitor C451.	12. Replace.
	Defective antenna coupling coil L412.	Replace.
	Defect in components of the antenna input filter (L413, L414, L415, C453, C454, C455).	Replace.
	Defective contacts on the antenna relay.	Repair and adjust.
	Defective antenna connector P403.	Replace.
13. Low or no grid drive to first audio-amplifier tube V411.	13. Defective handset.	13. Replace.
	Open winding in transformer T401.	Replace.
	Defective bypass capacitor C463 or limiting resistor R467.	Replace.
	Resistor R469 is shorted.	Replace.
	Defective resistors R465, R466.	Replace.

63. Trouble-shooting Chart (contd)

Symptom	Trouble	Correction
14. No audio output from tube V413 to phase modulator.	14. Defective tubes (V411, V412, V413).	14. Replace.
	Defective coupling capacitors C461, C457, or limiting resistor R459.	Replace.
	Defective components in the low-pass RC network (R456, C458).	Replace.
	Shorted feedback capacitor C456.	Replace.
	Faulty DEVIATION LEVEL control R452.	Replace.
	Defective resistor R450 or capacitor C408.	Replace.

64. D-c Resistance of Transformers and Coils

The d-c resistance of the transformer windings and the coils of Radio Transmitters T-278/U and T-416/GR are listed below:

Transformer or coil	Terminals	Ohms
T401	1-2 2-3 4-5	
K401		52
L401		25
L402	1-3	1.1
L403	1-3	1.1
L404	1-3	.33
L405	1-3	Less than .1 (continuity)
Z405	1-3	Less than .1 "
L406		Less than .1 "
L407		Less than .1 "
L408		Less than .1 "
L409		Less than .1 "
L410		Less than .1 "
L412		Less than .1 "
L413		Less than .1 "
L414		Less than .1 "
L501		Less than .1 "
L502		Less than .1 "
L503		Less than .1 "
L504		Less than .1 "
L505		Less than .1 "
L507		Less than .1 "

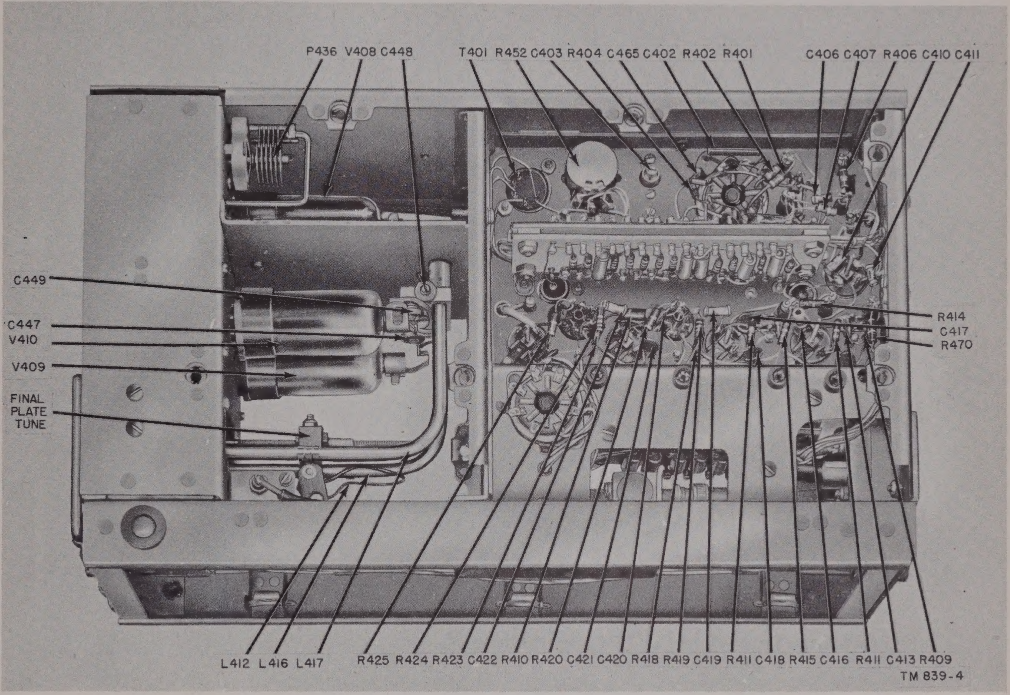

P436
V408
C448
T401
R452
C403
R404
C465
C402
R402
R401
C406
C407
R406
C410
C411
C449
C447
V410
V409
FINAL PLATE TUNE
R414
C417
R470
L412
L416
L417
R425
R424
R423
C422
R410
R420
C421
C420
R418
R419
C419
R411
C418
R415
C416
R411
C413
R409
TM 839-4

Figure 26. Radio Transmitter T-278/U, right side view showing components.

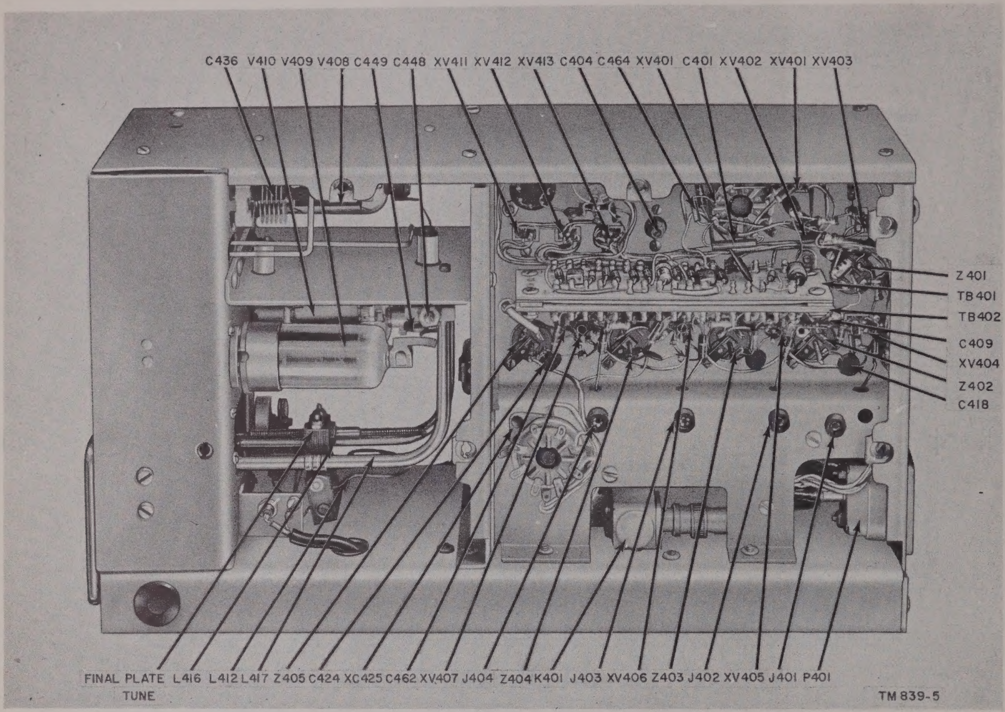

C436
V410
V409
V408
C449
C448
XV411
XV412
XV413
C404
C464
XV401
C401
XV402
XV401
XV403
Z401
TB401
TB402
C409
XV404
Z402
C418
FINAL PLATE TUNE
L416
L412
L417
Z405
C424
XC425
C462
XV407
J404
Z404
K401
J403
XV406
Z403
J402
XV405
J401
P401
TM 839-5

Figure 27. Radio Transmitter T-278/U, right side view showing sockets and jacks.

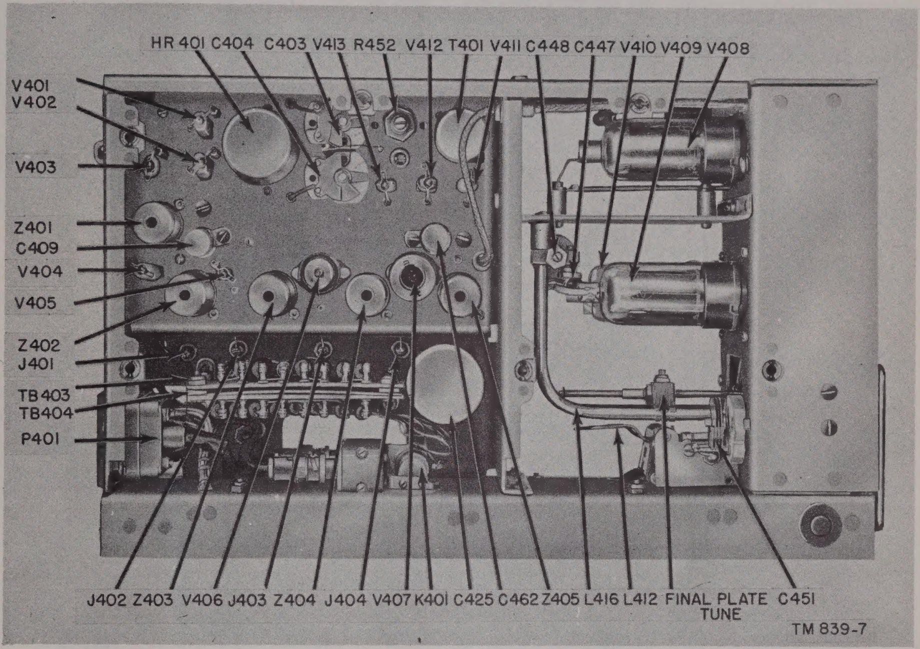

HR 401
C404
C403
V413
R452
V412
T401
V411
C448
C447
V410
V409
V408
V401
V402
V403
Z401
C409
V404
V405
Z402
J401
TB403
TB404
P401
J402
Z403
V406
J403
Z404
J404
V407
K401
C425
C462
Z405
L416
L412
FINAL PLATE TUNE
C451
TM 839-7

Figure 28. Radio Transmitter T-278/U, left side view.

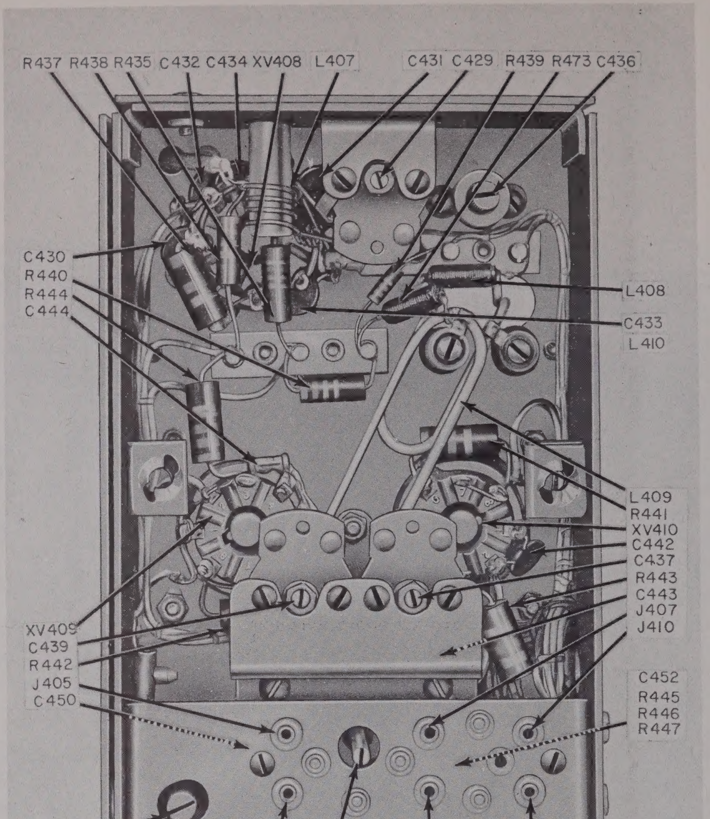

R437
R438
R435
C432
C434
XV408
L407
C431
C429
R439
R473
C436
C430
R440
R444
C444
L408
C433
L410
L409
R441
XV410
C442
C437
R443
C443
J407
J410
XV409
C439
R442
J405
C450
C452
R445
R446
R447
C451
TEST
OFF
MAX
MIN
COUPLING
TUNE
OPR
S402
J406
FINAL PLATE TUNE
L412
R448
R449
J408
S401
J409
TM 839-1

Figure 29. Radio Transmitter T-278/U, front view.

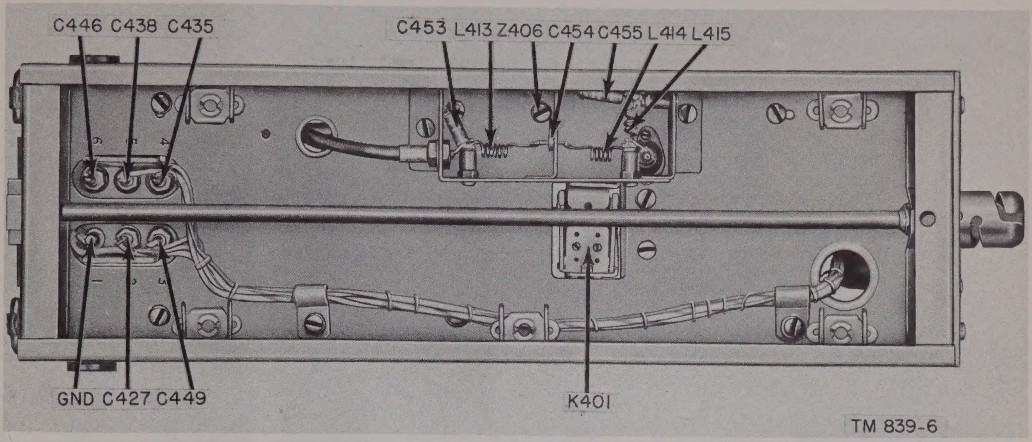

C446 C438 C435
C453 L413 Z406 C454 C455 L414 L415
GND C427 C449
K401
TM 839-6

Figure 30. Radio Transmitter T-278/U, bottom view.

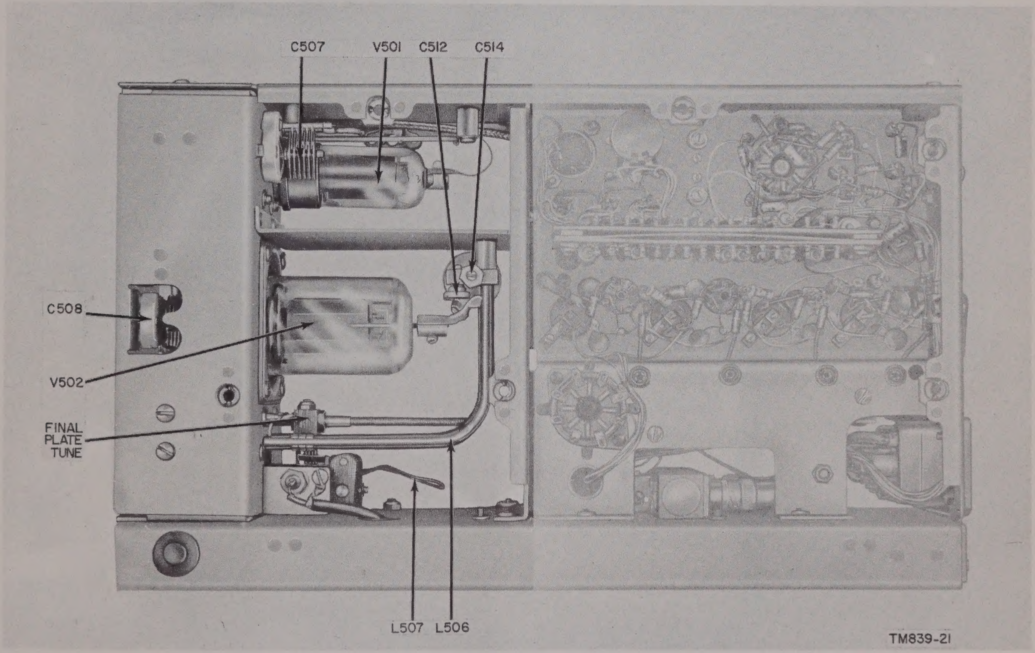

C507
V501
C512
C514
C508
V502
FINAL
PLATE
TUNE
L507
L506
TM839-21

Figure 31. Radio Transmitter T-416/GR, right side view.

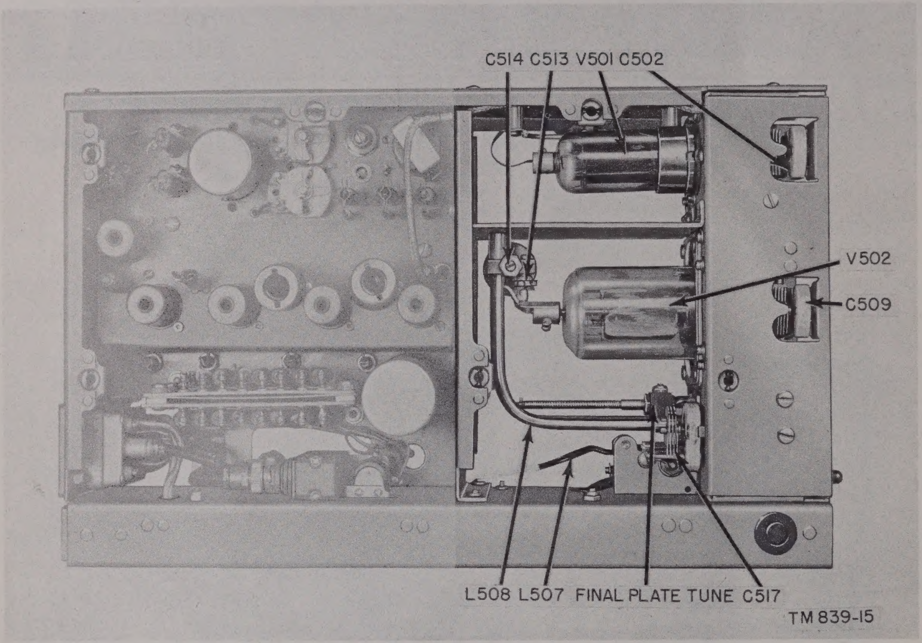

C514 C513 V501 C502
V502
C509
L508 L507 FINAL PLATE TUNE C517
TM 839-15

Figure 32. Radio Transmitter T-416/GR, left side view.

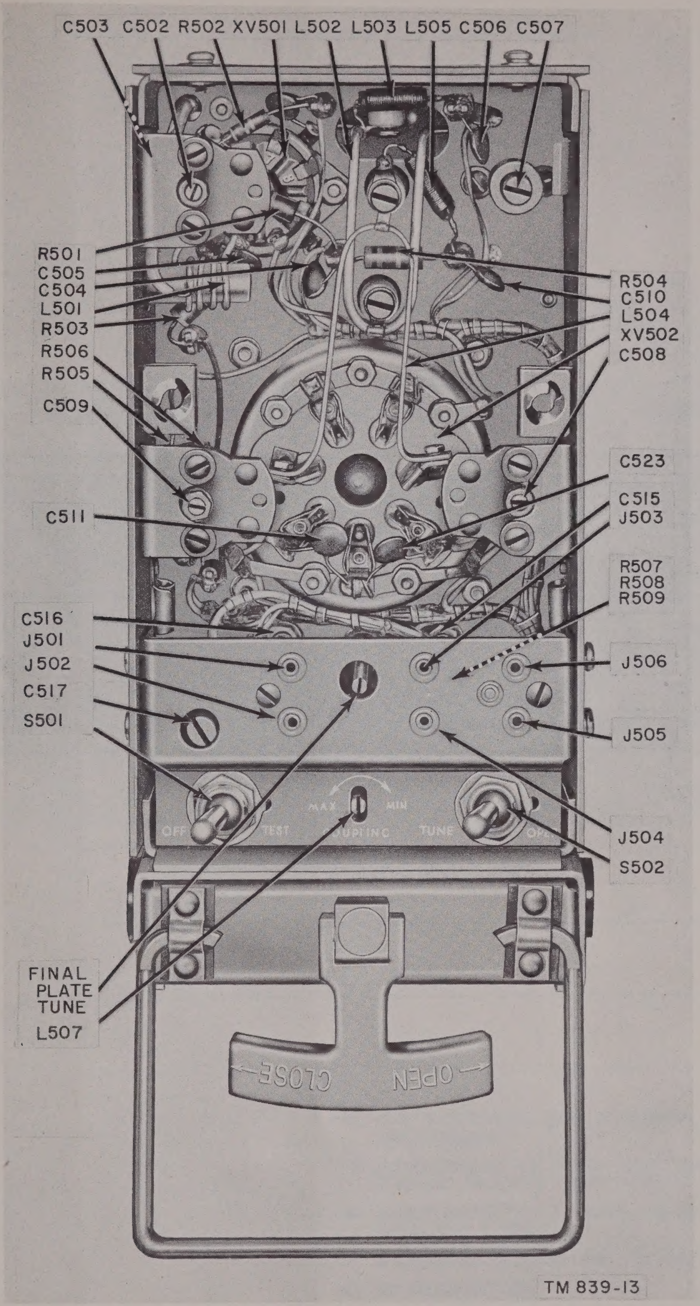

C503
C502
R502
XV501
L502
L503
L505
C506
C507
R501
C505
C504
L501
R503
R506
R505
C509
C511
C516
J501
J502
C517
S501
FINAL PLATE TUNE
L507
R504
C510
L504
XV502
C508
C523
C515
J503
R507
R508
R509
J506
J505
J504
S502
MAX
MIN
OFF
TEST
COUPLING
TUNE
OPER
CLOSE
OPEN
TM 839-13

Figure 33. Radio Transmitter T-416/GR, front view.

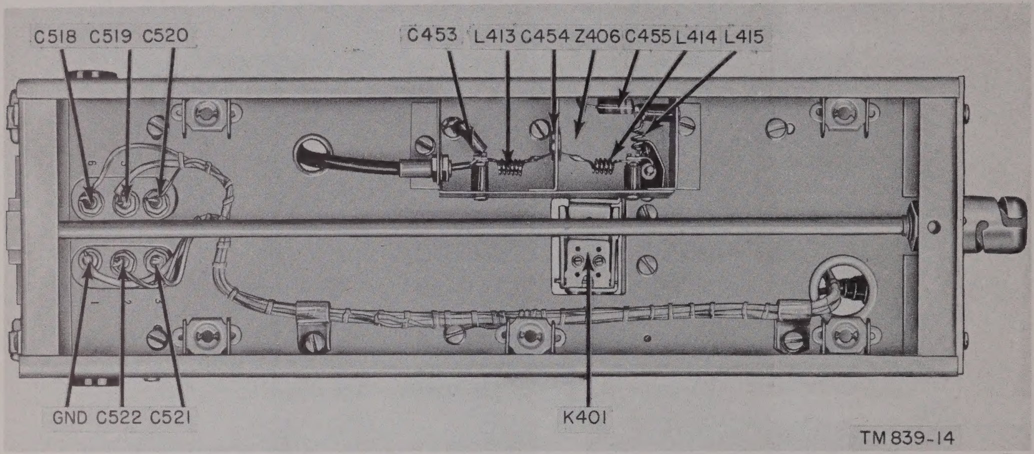
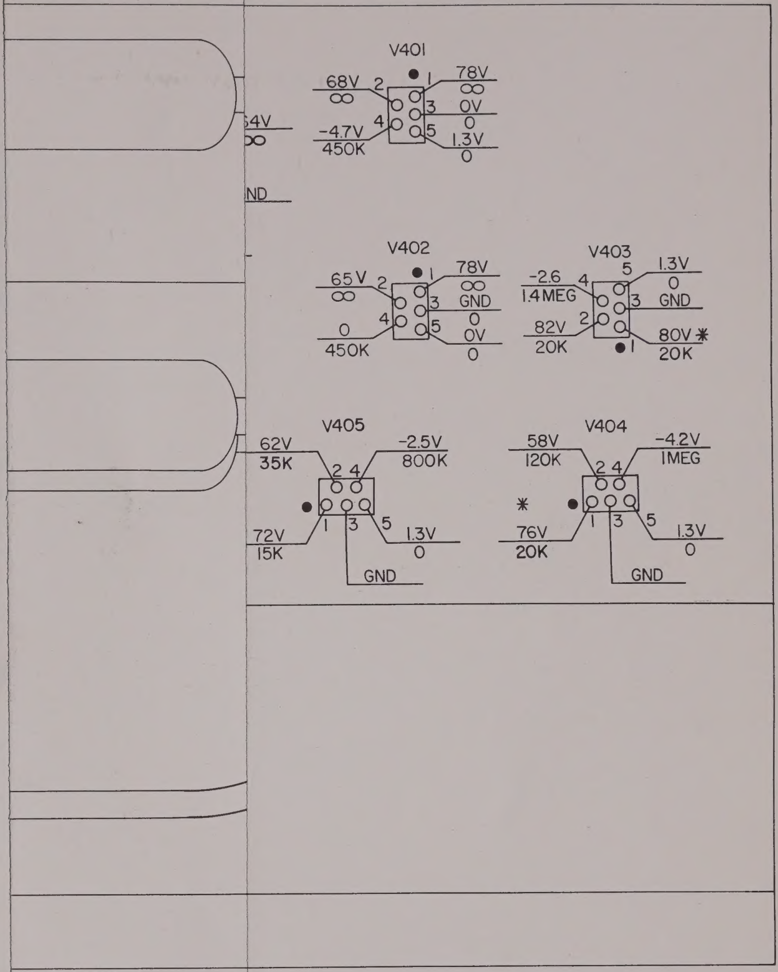

C518 C519 C520
C453 L413 C454 Z406 C455 L414 L415
GND C522 C521
K401
TM 839-14

Figure 34. Radio Transmitter T-416/GR, bottom view.


V401
68V
∞
2
1
78V
∞
3
0V
0
4
-4.7V
450K
5
1.3V
0
4V
∞
ND
V402
65V
∞
2
1
78V
∞
3
GND
0
4
0
450K
5
0V
0
V403
-2.6
1.4MEG
4
5
1.3V
0
3
GND
2
82V
20K
1
80V ✱
20K
V405
62V
35K
2 4
-2.5V
800K
1
72V
15K
3
GND
5
1.3V
0
V404
58V
120K
2 4
-4.2V
1MEG
✱
1
76V
20K
3
GND
5
1.3V
0

TES:

6. ✱ VOLTAGE READING TAKEN AT TERMINAL 3 OF DOUBLER TRANSFORMER.
7. RADIO TRANSMITTER T-278/U AND T-416/GR VOLTAGE READINGS TAKEN WITH 6.8V D-C INPUT.
8. RADIO TRANSMITTER T-416/GR VOLTAGE READINGS TAKEN WITH 120V A-C INPUT.

G.

9. ✱✱ READINGS DEPENDS UPON POSITION OF R452.
10. NC; NO CONNECTION.

TM 839-36

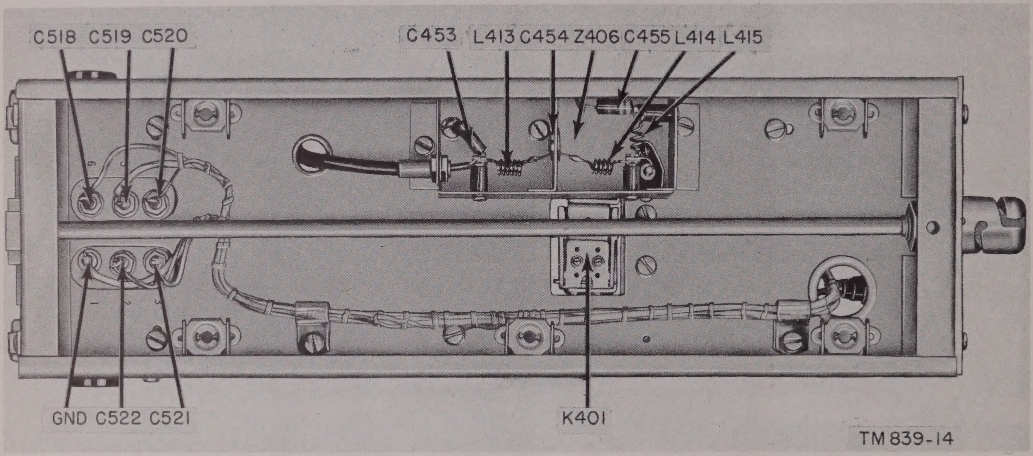
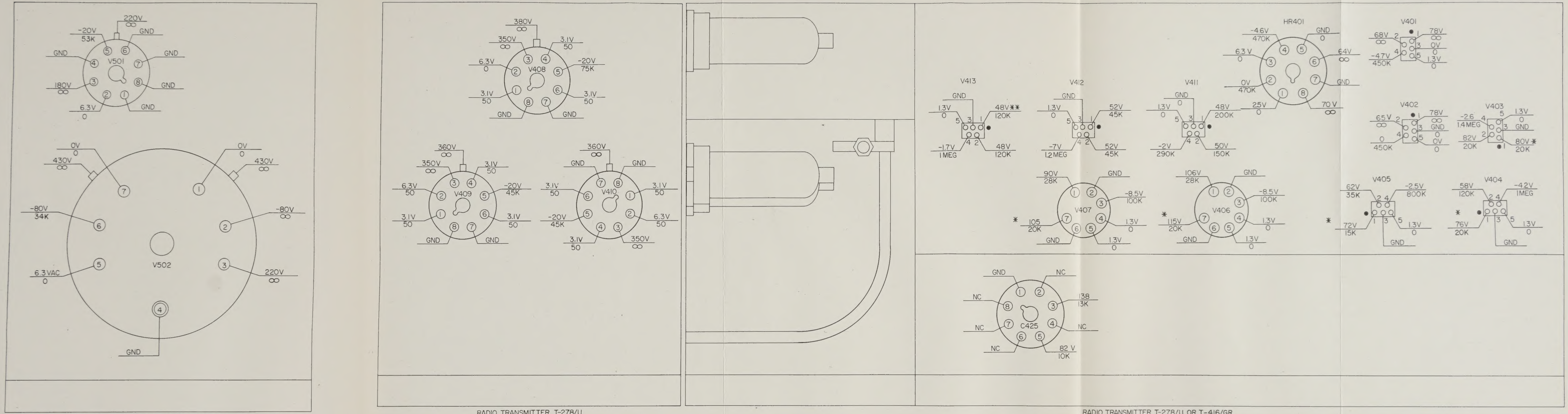

C518 C519 C520
C453 L413 C454 Z406 C455 L414 L415
GND C522 C521
K401
TM 839-14

Figure 34. Radio Transmitter T-416/GR, bottom view.



V501
220V
∞
-20V
53K
GND
GND
GND
180V
∞
GND
6.3V
0
GND
V502
0V
0
430V
∞
0V
0
430V
∞
-80V
34K
-80V
∞
6.3VAC
0
220V
∞
GND
V408
380V
∞
350V
∞
3.1V
50
6.3V
0
-20V
75K
3.1V
50
3.1V
50
GND
GND
V409
360V
∞
350V
∞
3.1V
50
6.3V
50
-20V
45K
3.1V
50
3.1V
50
GND
GND
V410
360V
∞
GND
GND
3.1V
50
3.1V
50
-20V
45K
6.3V
50
3.1V
50
350V
∞
V413
GND
1.3V
0
48V✱✱
120K
-1.7V
1MEG
48V
120K
V412
GND
1.3V
0
52V
45K
-7V
1.2MEG
52V
45K
V411
GND
0
1.3V
0
48V
200K
-2V
290K
50V
150K
HR401
-4.6V
470K
GND
0
6.3V
0
64V
∞
0V
470K
GND
25V
0
70V
∞
V401
68V
∞
78V
∞
0V
0
-4.7V
450K
1.3V
0
V402
65V
∞
78V
∞
GND
0
0
450K
0V
0
V403
-2.6
1.4MEG
1.3V
0
GND
82V
20K
80V ✱
20K
V407
90V
28K
GND
-8.5V
100K
✱
105
20K
1.3V
0
GND
1.3V
0
V406
106V
28K
GND
-8.5V
100K
✱
115V
20K
1.3V
0
GND
1.3V
0
V405
62V
35K
-2.5V
800K
✱
72V
15K
1.3V
0
GND
V404
58V
120K
-4.2V
1MEG
✱
76V
20K
1.3V
0
GND
C425
GND
NC
NC
138
13K
NC
NC
NC
82 V
10K

RADIO TRANSMITTER T-416/GR
FRONT

RADIO TRANSMITTER T-278/U
FRONT

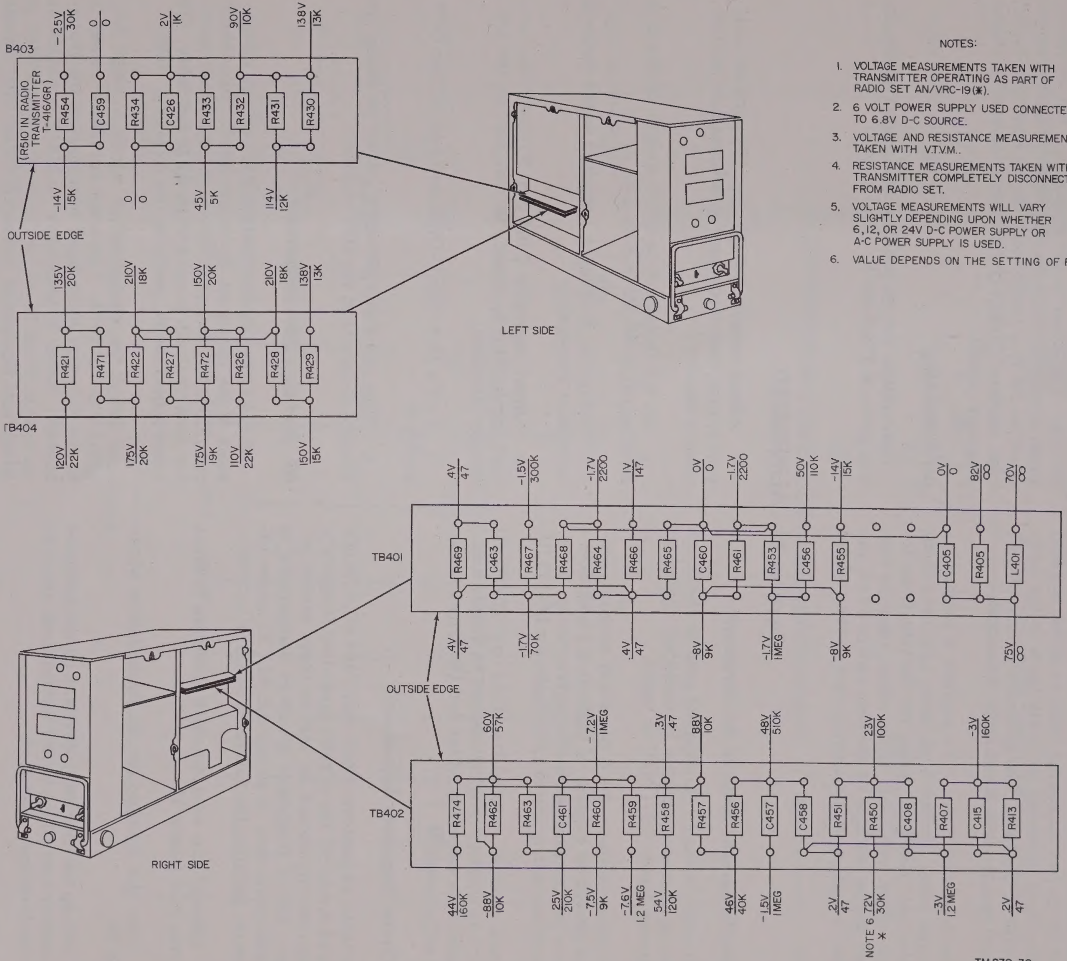
RADIO TRANSMITTER T-278/U OR T-416/GR
RIGHT SIDE

NOTES:

1. ALL VOLTAGE AND RESISTANCE READINGS TAKEN WITH V.T.V.M. BETWEEN TERMINAL AND GROUND CHASSIS.
2. RESISTANCE READING TAKEN WITH TRANSMITTER COMPLETELY DISCONNECTED FROM RADIO SET.
3. READINGS TAKEN WITH S401 IN OPR POSITION.
4. ON SUBMINITURE TUBE SOCKETS, THE PIN CLOSEST, TO THE RED DOT IS PIN 1, AND IS SHOWN BY A BLACK DOT ON DRAWING.
5. OSCILLATOR SELECTOR SWITCH SHOULD BE SET AT FREQ 1 POSITION.
6. ✱ VOLTAGE READING TAKEN AT TERMINAL 3 OF DOUBLER TRANSFORMER.
7. RADIO TRANSMITTER T-278/U AND T-416/GR VOLTAGE READINGS TAKEN WITH 6.8V D-C INPUT.
8. RADIO TRANSMITTER T-416/GR VOLTAGE READINGS TAKEN WITH 120V A-C INPUT.
9. ✱✱ READINGS DEPENDS UPON POSITION OF R452.
10. NC; NO CONNECTION.

TM 839-36

Figure 35. Radio Transmitters T-278/U and T-416/GR voltage and resistance at tube sockets.


B403
(R510 IN RADIO TRANSMITTER T-416/GR)
R454 C459 R434 C426 R433 R432 R431 R430
−25V 30K
0 0
2V 1K
90V 10K
138V 13K
−14V 15K
0 0
45V 5K
114V 12K
OUTSIDE EDGE
TB404
R421 R471 R422 R427 R472 R426 R428 R429
135V 20K
210V 18K
150V 20K
210V 18K
138V 13K
120V 22K
175V 20K
175V 19K
110V 22K
150V 15K
LEFT SIDE
TB401
R469 C463 R467 R468 R464 R466 R465 C460 R461 R453 C456 R455 C405 R405 L401
.4V 47
−1.5V 300K
−1.7V 2200
1V 147
0V 0
−1.7V 2200
50V 110K
−14V 15K
0V 0
82V ∞
70V ∞
.4V 47
−1.7V 70K
.4V 47
−8V 9K
−1.7V 1MEG
−8V 9K
75V ∞
OUTSIDE EDGE
TB402
R474 R462 R463 C461 R460 R459 R458 R457 R456 C457 C458 R451 R450 C408 R407 C415 R413
60V 57K
−7.2V 1MEG
.3V .47
88V 10K
48V 510K
23V 100K
−3V 160K
44V 160K
−88V 10K
25V 210K
−7.5V 9K
−7.6V 1.2 MEG
54V 120K
46V 40K
−1.5V 1MEG
2V 47
72V 30K
NOTE 6 *
−3V 1.2 MEG
2V 47
RIGHT SIDE
TM 839-38

NOTES:

1. VOLTAGE MEASUREMENTS TAKEN WITH TRANSMITTER OPERATING AS PART OF RADIO SET AN/VRC-19(*).
2. 6 VOLT POWER SUPPLY USED CONNECTED TO 6.8V D-C SOURCE.
3. VOLTAGE AND RESISTANCE MEASUREMENTS TAKEN WITH V.T.V.M..
4. RESISTANCE MEASUREMENTS TAKEN WITH TRANSMITTER COMPLETELY DISCONNECTED FROM RADIO SET.
5. VOLTAGE MEASUREMENTS WILL VARY SLIGHTLY DEPENDING UPON WHETHER 6, 12, OR 24V D-C POWER SUPPLY OR A-C POWER SUPPLY IS USED.
6. VALUE DEPENDS ON THE SETTING OF R 452.

Figure 36. Radio Transmitters T-278/U and T-416/GR voltage and resistance at terminal boards.

Section II. REPAIRS

65. Replacement of Parts

a. Power-amplifier Tube. The 5894A power-amplifier tube in Radio Transmitter T-416/GR may be removed by first loosening (with an Allen wrench) the setscrews securing the plate leads to the plate terminals of the tube. The plate leads then may be removed and the tube lifted from its socket.

b. Subminiature-type Tubes. To remove a subminiature-type tube, lift the hold-down clip away from the tube and then very gently lift the tube from its socket. When replacing these tubes, observe that the red dot on the side of the tube indicates pin number 1 and must be located next to the red dot painted on the socket. Underneath the chassis, pin number 1 is indicated as the pin closest to a red dot painted directly on the chassis. The remaining pins are numbered according to their positions in relation to pin number 1. Replacement tubes are furnished with long leads attached, which must be cut to a length suitable for insertion in the tube socket. Carefully cut these leads with sharp diagonal cutters.

66. Refinishing

Instructions for refinishing badly marred panels are given in TM 9-2851.

Section III. ALINEMENT

67. Test Equipment Required for Alinement

a. Frequency Standard. Equipment used to check the operating frequency of the transmitter should be Frequency Meter TS-174/U or equal.

b. Deviation Monitor. The deviation monitor employed should be capable of indicating 15-kc deviation at the transmitter operating frequency. A recommended unit is Panoramic Indicator IP-173/U.

c. Audio Oscillator. Audio Oscillator TS-382/U or equivalent, will be needed to supply audio modulation to the transmitter for the deviation limit adjustment.

68. Crystal Frequency Adjustment

Variable capacitors C403 and C404 allow slight adjustment of the crystal operating frequency. These controls should be left in their center position. Use a frequency standard comparable to the unit described in paragraph 67. To make adjustment, perform the following steps:

a. Connect the equipment as shown in block diagram A of figure 38.

b. Tune the transmitter as described in paragraph 19.

c. Set up the frequency standard on the assigned transmitter frequency; follow instructions supplied with the frequency standard.

d. At Radio Set Control C-847/U, turn the VOLUME-OFF switch toward the VOLUME position and set the frequency selector switch to FREQ 1.

e. Turn the TEST-OFF switch on the transmitter to the TEST position.

f. Adjust capacitor C403 (fig. 37) until the correct transmitter frequency is indicated on the frequency standard.

g. Set the frequency selector switch on Radio Set Control C-847/U to FREQ 2.

h. Set up the frequency standard to the desired oscillator frequency.

i. Adjust capacitor C404 (fig. 37) until the correct transmitter frequency is indicated by the frequency standard.

j. Turn the TEST-OFF switch to the OFF position.

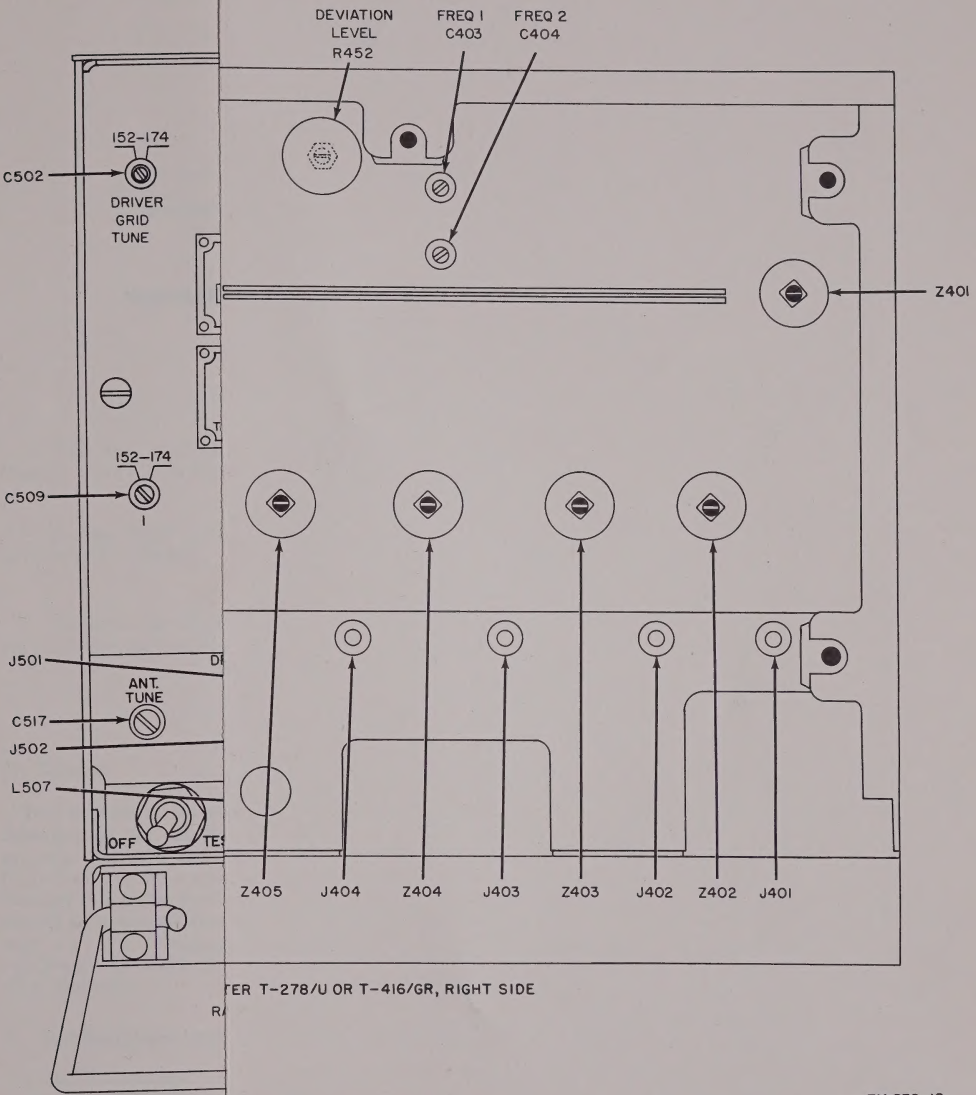
k. Turn the VOLUME-OFF switch on Radio Set Control C-847/U to the OFF position.

69. Deviation Limit Adjustment

DEVIATION LEVEL control R452 allows adjustment of the maximum deviation level. Adjustment should not be attempted unless the deviation monitor described in paragraph 67 is available. To make adjustments, perform the following steps:

a. Set up the equipment as shown in block diagram B of figure 38. The audio oscillator connects to the 600-ohm audio input terminals of the transmitter. Radio Transmitter T-278/U connects to terminals 9 and 10 of terminal board TB801 in Electrical Equipment Cabinet CY-938/VRC. Radio Transmitter T-416/GR connects to terminals 5 and 10 of terminal board TB1902 in Electrical Equipment Cabinet CY-1221/U.

b. Set the frequency of the audio oscillator at 1,000 cycles and the input level at minimum.


DEVIATION LEVEL R452
FREQ 1 C403
FREQ 2 C404
152–174
C502
DRIVER GRID TUNE
Z401
152–174
C509
1
J501
DR
ANT. TUNE
C517
J502
L507
OFF
TES
Z405
J404
Z404
J403
Z403
J402
Z402
J401

TER T-278/U OR T-416/GR, RIGHT SIDE

RA

TM 839-18

Section II. REPAIRS

65. Replacement of Parts

a. Power-amplifier Tube. The 5894A power-amplifier tube in Radio Transmitter T-416/GR may be removed by first loosening (with an Allen wrench) the setscrews securing the plate leads to the plate terminals of the tube. The plate leads then may be removed and the tube lifted from its socket.

b. Subminiature-type Tubes. To remove a subminiature-type tube, lift the hold-down clip away from the tube and then very gently lift the tube from its socket. When replacing these tubes, observe that the red dot on the side of the tube indicates pin number 1 and must be located next to the red dot painted on the socket. Underneath the chassis, pin number 1 is indicated as the pin closest to a red dot painted directly on the chassis. The remaining pins are numbered according to their positions in relation to pin number 1. Replacement tubes are furnished with long leads attached, which must be cut to a length suitable for insertion in the tube socket. Carefully cut these leads with sharp diagonal cutters.

66. Refinishing

Instructions for refinishing badly marred panels are given in TM 9-2851.

Section III. ALINEMENT

67. Test Equipment Required for Alinement

a. Frequency Standard. Equipment used to check the operating frequency of the transmitter should be Frequency Meter TS-174/U or equal.

b. Deviation Monitor. The deviation monitor employed should be capable of indicating 15-kc deviation at the transmitter operating frequency. A recommended unit is Panoramic Indicator IP-173/U.

c. Audio Oscillator. Audio Oscillator TS-382/U or equivalent, will be needed to supply audio modulation to the transmitter for the deviation limit adjustment.

68. Crystal Frequency Adjustment

Variable capacitors C403 and C404 allow slight adjustment of the crystal operating frequency. These controls should be left in their center position. Use a frequency standard comparable to the unit described in paragraph 67. To make adjustment, perform the following steps:

a. Connect the equipment as shown in block diagram A of figure 38.

b. Tune the transmitter as described in paragraph 19.

c. Set up the frequency standard on the assigned transmitter frequency; follow instructions supplied with the frequency standard.

d. At Radio Set Control C-847/U, turn the VOLUME-OFF switch toward the VOLUME position and set the frequency selector switch to FREQ 1.

e. Turn the TEST-OFF switch on the transmitter to the TEST position.

f. Adjust capacitor C403 (fig. 37) until the correct transmitter frequency is indicated on the frequency standard.

g. Set the frequency selector switch on Radio Set Control C-847/U to FREQ 2.

h. Set up the frequency standard to the desired oscillator frequency.

i. Adjust capacitor C404 (fig. 37) until the correct transmitter frequency is indicated by the frequency standard.

j. Turn the TEST-OFF switch to the OFF position.

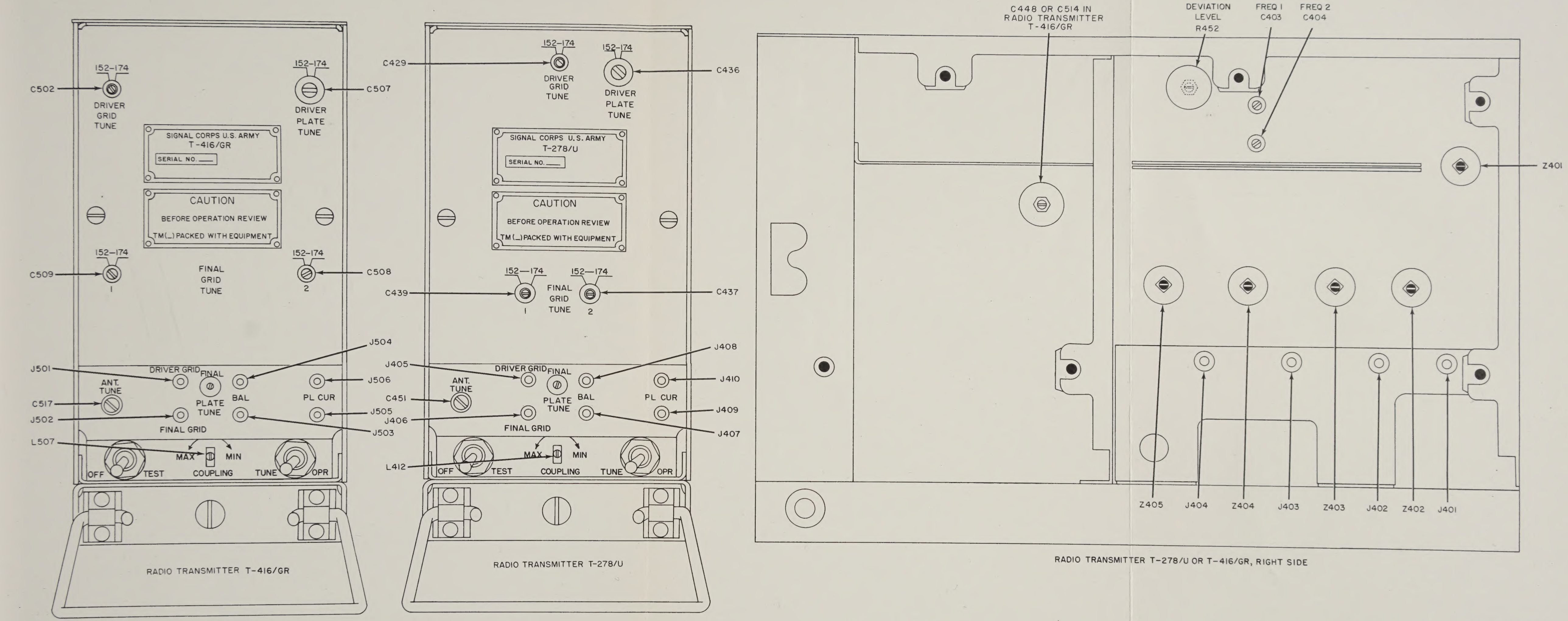
k. Turn the VOLUME-OFF switch on Radio Set Control C-847/U to the OFF position.

69. Deviation Limit Adjustment

DEVIATION LEVEL control R452 allows adjustment of the maximum deviation level. Adjustment should not be attempted unless the deviation monitor described in paragraph 67 is available. To make adjustments, perform the following steps:

a. Set up the equipment as shown in block diagram B of figure 38. The audio oscillator connects to the 600-ohm audio input terminals of the transmitter. Radio Transmitter T-278/U connects to terminals 9 and 10 of terminal board TB801 in Electrical Equipment Cabinet CY-938/VRC. Radio Transmitter T-416/GR connects to terminals 5 and 10 of terminal board TB1902 in Electrical Equipment Cabinet CY-1221/U.

b. Set the frequency of the audio oscillator at 1,000 cycles and the input level at minimum.


C502
152–174
DRIVER GRID TUNE
152–174
C507
DRIVER PLATE TUNE
SIGNAL CORPS U.S. ARMY
T-416/GR
SERIAL NO.
CAUTION
BEFORE OPERATION REVIEW
TM(_) PACKED WITH EQUIPMENT
152–174
C509
1
FINAL GRID TUNE
152–174
C508
2
J504
J501
DRIVER GRID
FINAL
ANT. TUNE
BAL
J506
PL CUR
C517
PLATE TUNE
J505
J502
FINAL GRID
J503
L507
MAX
MIN
COUPLING
OFF
TEST
TUNE
OPR
RADIO TRANSMITTER T-416/GR
C429
152–174
DRIVER GRID TUNE
152–174
C436
DRIVER PLATE TUNE
SIGNAL CORPS U.S. ARMY
T-278/U
SERIAL NO.
CAUTION
BEFORE OPERATION REVIEW
TM (_) PACKED WITH EQUIPMENT
152—174
152—174
C439
FINAL GRID TUNE
C437
1
2
J408
J405
DRIVER GRID
FINAL
ANT. TUNE
BAL
J410
PL CUR
C451
PLATE TUNE
J409
J406
FINAL GRID
J407
L412
MAX
MIN
COUPLING
OFF
TEST
TUNE
OPR
RADIO TRANSMITTER T-278/U
C448 OR C514 IN RADIO TRANSMITTER T-416/GR
DEVIATION LEVEL R452
FREQ 1 C403
FREQ 2 C404
Z401
Z405
J404
Z404
J403
Z403
J402
Z402
J401
RADIO TRANSMITTER T-278/U OR T-416/GR, RIGHT SIDE

TM 839-18

Figure 37. Radio Transmitters T-278/U, and T-416/GR, test and alinement points.

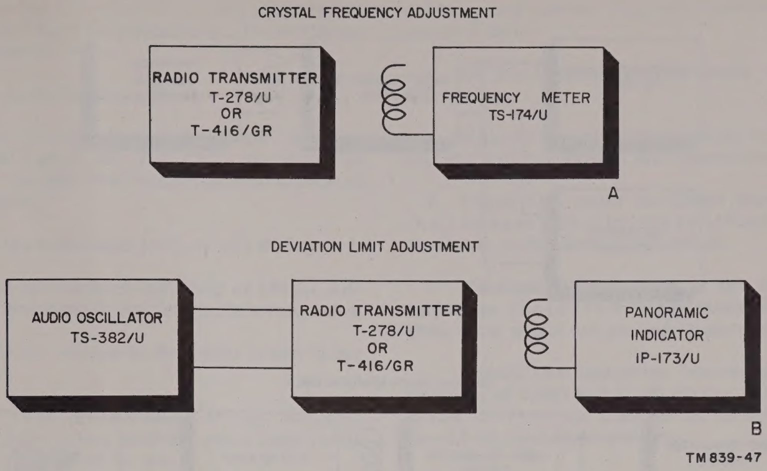


Figure 38. Radio Transmitters T-278/U, and T-416/GR adjustment, block diagrams.

c. Turn the VOLUME-OFF switch on Radio Set Control C-847/U to the VOLUME position.

d. Set the TEST-OFF switch on the transmitter to the TEST position.

e. Tune the deviation monitor to the transmitter signal; follow instructions supplied with the monitor.

f. Observe the modulation deviation on the monitor, and advance the audio oscillator level until no further increase in deviation is produced with an increase in audio level.

g. Adjust DEVIATION LEVEL control R452 (fig. 37) on the transmitter for a deviation of 15 kc.

h. Turn the TEST-OFF switch on the transmitter to the OFF position.

Section IV. FINAL TESTING

70. General

This section is intended as a guide to be used in determining the quality of repaired Radio Transmitters T-278/U and T-416/GR. The maximum test requirements outlined in paragraphs 72 through 75 may be performed by maintenance personnel with adequate test equipment and the necessary skills. Repaired equipment meeting these requirements will furnish uniformly satisfactory operation.

71. Test Equipment Required for Final Testing

a. Distortion Analyzer. Measurements for distortion should be made with Sound Analyzer TS-615/U, or an equivalent unit.

b. Test Receiver. The test receiver should be capable of tuning to 160 mc. The audio distortion introduced by this test receiver should be no more than 4 percent at the audio level used for testing. The frequency response curve of the receiver must be known.

c. Audio Voltmeter. Two audio voltmeters are required. These should be Multimeter TS-352/U, or equivalent.

d. Deviation Monitor. Refer to paragraph 67b.

e. Audio Oscillator. Refer to paragraph 67c.

f. RF Wattmeter. The r-f wattmeter used should be Radio Frequency Wattmeter TS-118/AP, or equivalent. Power output measurements will be approximately 30 watts.

72. Deviation Limit Check

a. Connect the equipment as shown in block diagram A of figure 39.

b. Set the frequency of the audio oscillator at 1,000 cycles and the input level at 5 volts.

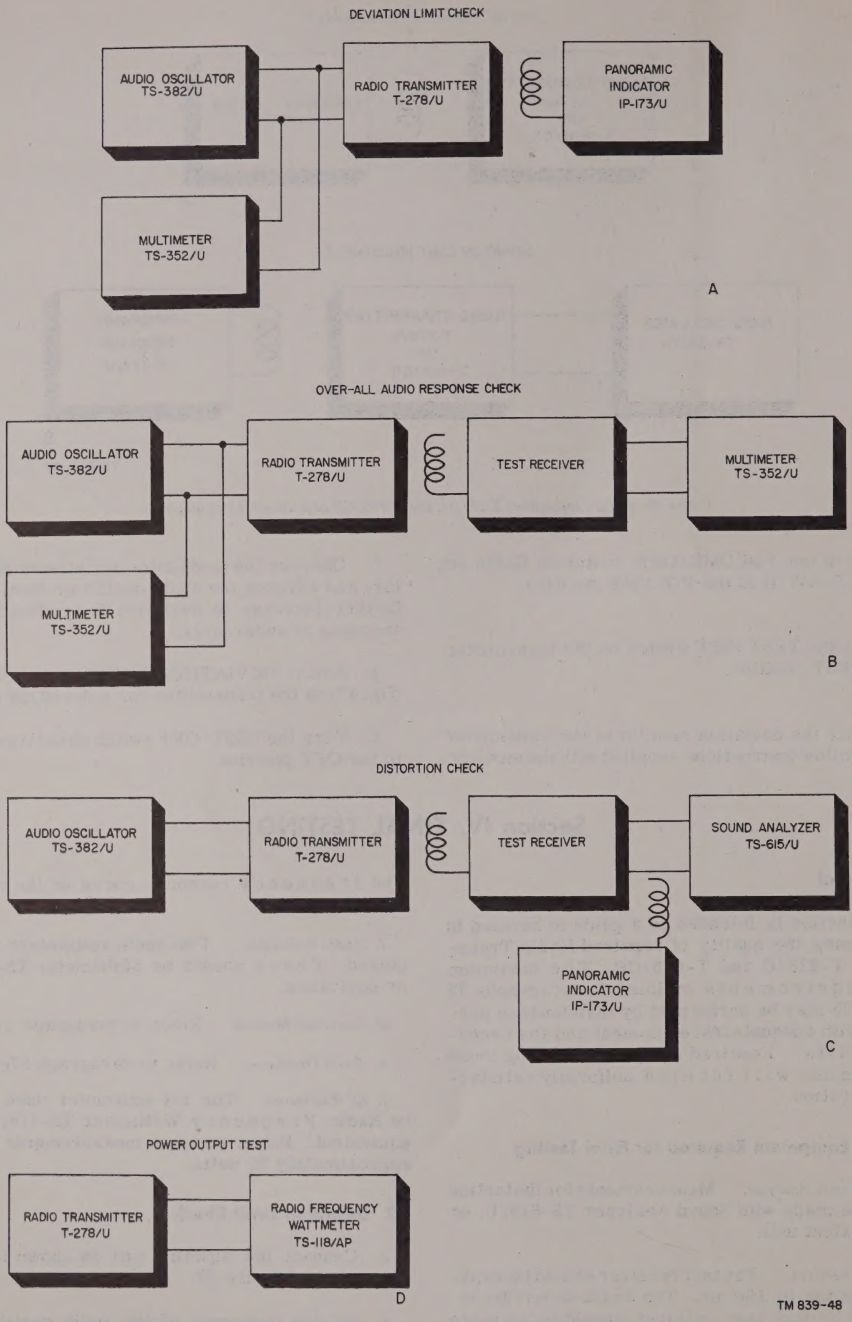

DEVIATION LIMIT CHECK
AUDIO OSCILLATOR TS-382/U
RADIO TRANSMITTER T-278/U
PANORAMIC INDICATOR IP-173/U
MULTIMETER TS-352/U
A
OVER-ALL AUDIO RESPONSE CHECK
AUDIO OSCILLATOR TS-382/U
RADIO TRANSMITTER T-278/U
TEST RECEIVER
MULTIMETER TS-352/U
MULTIMETER TS-352/U
B
DISTORTION CHECK
AUDIO OSCILLATOR TS-382/U
RADIO TRANSMITTER T-278/U
TEST RECEIVER
SOUND ANALYZER TS-615/U
PANORAMIC INDICATOR IP-173/U
C
POWER OUTPUT TEST
RADIO TRANSMITTER T-278/U
RADIO FREQUENCY WATTMETER TS-118/AP
D
TM 839-48

Figure 39. Radio Transmitters T-278/U and T-416/GR, test, block diagram.

c. Operate the transmitter and observe the modulation deviation on the monitor. The deviation should not exceed 15 kc.

73. Over-all Audio Response Check

a. Connect the equipment as shown in block diagram B of figure 39. The audio oscillator is connected to the 600-ohm audio input terminals of the transmitter.

b. Adjust the audio input to 40 mv at 1,000 cycles.

c. With the transmitter operating on 160 mc, adjust the test receiver to the transmitter frequency.

d. Record the voltage at the audio output of the test receiver.

e. Repeat this measurement at 100, 200, 400, 2,000, and 3,500 cycles; hold the audio input to the transmitter constant at 40 mv.

f. Make corrections for the test receiver frequency response (including correction for a 6-db rising characteristic if this compensation is not incorporated in the test receiver).

g. The response at 100 cycles should not depart from that at 1,000 cycles by more than ± 1 db. The response at 3,500 cycles should not be down more than 4 db.

74. Distortion Check

a. Set up the equipment as shown in block diagram C of figure 39. The distortion analyzer is connected across the test receiver audio output terminals.

b. Set the frequency of the audio oscillator at 800 cycles.

c. With the transmitter operating at 160 mc, adjust the test receiver to the transmitter frequency.

d. Adjust the audio oscillator input level into the transmitter to give an indication of 12-kc deviation on the deviation monitor.

e. Measure the distortion at the test receiver output, as indicated by the distortion analyzer. This value would not exceed 10 percent.

f. Repeat the distortion measurement at frequencies of 2,000 and 3,500 cycles; hold the transmitter deviation constant at 12 kc. Distortion should not exceed 10 percent.

75. Power Output Test

a. Tune Radio Transmitter T-278/U, (pars. 18 and 19) for an operating frequency of 152 mc.

b. Connect the antenna terminal (terminal A2 on Electrical Equipment Cabinet CY-938/VRC) to an r-f wattmeter (block diagram D, fig. 39).

c. Operate the transmitter and observe the power output indicated on the wattmeter. This should be at least 25 watts.

Note. When operating at frequencies above 162 mc, the power output may be as low as 20 watts.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

76. Disassembly

Radio Transmitters T-278/U and T-416/GR is a plug-in unit normally stored and transported in Electrical Equipment Cabinet CY-938/VRC or Case CY-1221/U. To separate the transmitter from the system in which it operates, it is necessary only to remove it from the system case unit.

77. Repacking for Shipment or Limited Storage

a. The exact procedure in repacking for shipment or limited storage depends on the material available and the conditions under which the equipment is to be shipped or stored. Normally, the transmitter will be housed in Electrical Equipment Cabinet CY-938/VRC or Case CY-1221/U for storage.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the inner carton. Protect the transit case with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected case in a padded wooden case; provide at least 3 inches of excelsior padding between the paper barrier and the packing case.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

78. General

The demolition procedures outlined in paragraph 79 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only on order of the commander.

79. Methods of Destruction

a. Smash. Smash the crystals, controls, tubes, coils, switches, capacitors, and transformers, using sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut. Cut cords and wiring, using axes, handaxes, or machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals, using gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, cabinet, and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into streams.

g. Destroy. DESTROY EVERYTHING.

APPENDIX I

REFERENCES

Note. For availability of items listed, check SR-310-20-3, SR-310-20-4, and SR-310-20-5. Check Department of the Army Supply Catalog SIG 1 for Signal Corps Supply Catalog pamphlets.

1. Army Regulations

AR 380-5	Military Security (Safeguarding Military Information).
AR 750-5	Maintenance of Supplies and Equipment (Maintenance Responsibilities and Shop Operation).

2. Supply Bulletins

SB 11-47	Preparation and Submission of Requisitions for Signal Corps Supplies.
SB 11-76	Signal Corps Kit and Materials for Moisture- and Fungi-Resistant Treatment.

3. Auxiliary Equipment and Test Equipment

NAVSHIPS 91, 272	Oscilloscope OS-8/U.
TM 11-2624B	Voltohmmeters, TS-294/U, TS-294B/U, and TS-294C/U.
TM 11-2626	Test Unit I-176, I-176-A, and I-176-B.
TM 11-2627	Tube Tester I-177 and I-177-A.
TM 11-2627-3	Adapter Kit MX-949.
TM 11-2684	Audio Oscillator TS-382/U.
TM 11-4700	Electrical Indicating and Measuring Instruments, Repair Instructions.
TM 11-5044	Frequency Meter TS-174/U.
TM 11-5527	Multimeter TS-352/U.

4. Painting, Preserving, and Lubrication

TB SIG 13	Moistureproofing and Fungiproofing Signal Corps Equipment.
TB SIG 69	Lubrication of Ground Signal Equipment.
TM 9-2851	Painting Instructions for Field Use.

5. Demolition

FM 5-25	Explosives and Demolitions.

6. Other Publications

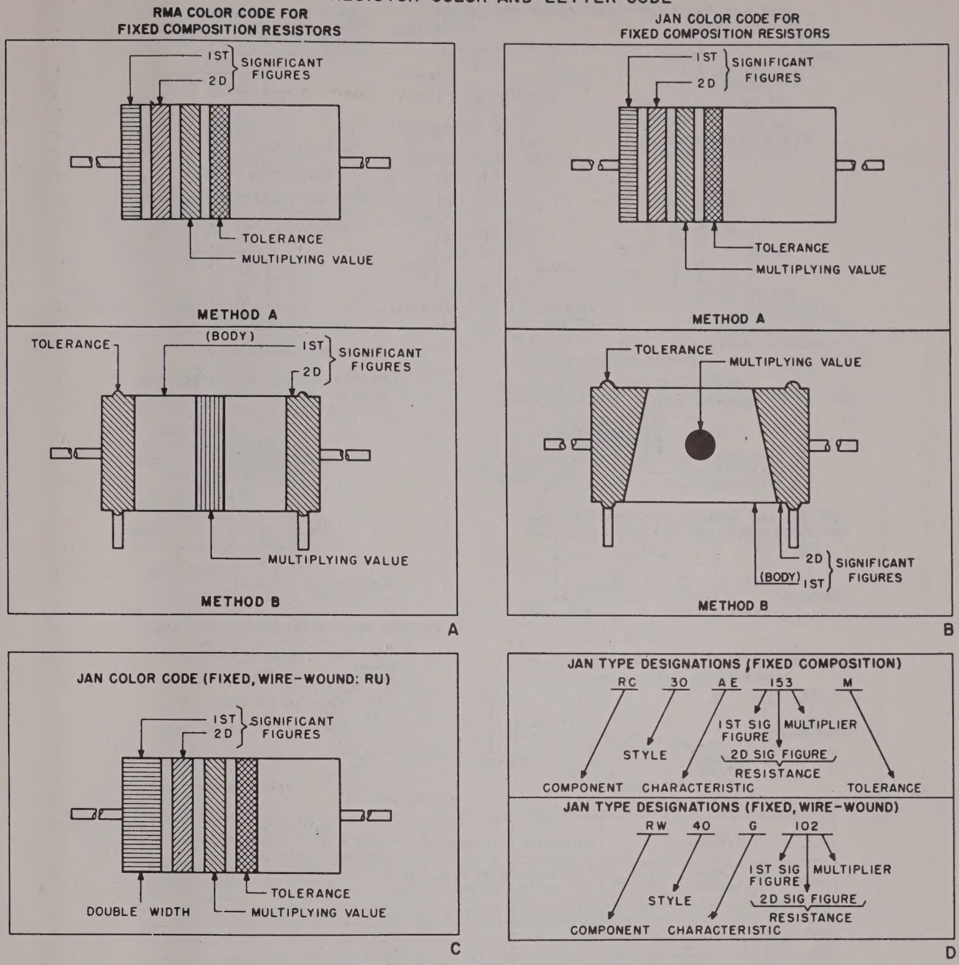
FM 24-18	Field Radio Techniques.
FM 72-20	Jungle Warfare.
SR 310-20-3	Index of Training Publications.
SR 310-20-4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Table of Organization and Equipment, Reduction Tables, Tables of Allowances, Table of Organization, and Tables of Equipment.
SR 310-20-5	Index of Administrative Publications.
SR 700-45-5	Unsatisfactory Equipment Report (Reports Control Symbol CSGLD-247).
SR 745-45-5)) NAV DEPT) SERIAL 85P00)) AFR 71-4)	Report of Damaged or Improper Shipment (Reports Control Symbols CSGLD-66 (Army), SandA-70-6 (Navy), and AF-MC-U2 (Air Force)).
TB SIG 25	Preventive Maintenance of Power Cords.
TB SIG 54	Working through Jamming with Frequency Modulated Radio Sets.
TB SIG 66	Winter Maintenance of Signal Equipment.
TB SIG 72	Tropical Maintenance of Ground Signal Equipment.
TB SIG 75	Desert Maintenance of Ground Signal Equipment.
TB SIG 123	Preventive Maintenance Practices for Ground Signal Equipment.
TB SIG 178	Preventive Maintenance Guide for Radio Communication Equipment.
TB SIG 219	Operation of Signal Equipment at Low Temperatures.
TM 11-4534	Shop Work.
TM 11-455	Radio Fundamentals.
TM 11-483	Suppression of Radio Noises.
TM 11-661	Electrical Fundamentals (Direct Current).

TM 11-662	Basic Theory and Application of Electron Tubes.
TM 11-681	Electrical Fundamentals (Alternating Current).
TM 11-4000	Trouble Shooting and Repair of Radio Equipment.

7. Abbreviations

a-c	alternating-current
a-f	audio-frequency
AGO	Adjustant General's Office
a-m	amplitude-modulated
amp	ampere
ampl	amplifier
ant.	antenna
BAL	balance
C	capacitance
cps	cycles per second
ct.	center tap
CUR	current
dc.	direct current
db.	decibel
DBLR	doubler
DRVR	driver
f-m.	frequency-modulated
FREQ	frequency
h-f	high-frequency
k-c	kilocycle
lb	pound
ma	milliampere
MAX	maximum
mc	megacycle
MEG	megohm
MH	millihenry
MIN	minimum
MOD	modulator
mv	millivolt
OPR	operate
OSC	oscillator
PL	plate
psi	pound per square inch
PWR	power
R	resistance
r-c	resistance-capacitance
r-f	radio-frequency
SD	solvent, dry cleaning
UF	microfarad
UH	microhenry
UUF	micromicrofarad
v	volt
vhf	very high-frequency
VTVM	vacuum-tube voltmeter
Z	impedance

RESISTOR COLOR AND LETTER CODE


RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS
1ST
2D
SIGNIFICANT FIGURES
TOLERANCE
MULTIPLYING VALUE
METHOD A
TOLERANCE
(BODY)
1ST
2D
SIGNIFICANT FIGURES
MULTIPLYING VALUE
METHOD B
A
JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS
1ST
2D
SIGNIFICANT FIGURES
TOLERANCE
MULTIPLYING VALUE
METHOD A
TOLERANCE
MULTIPLYING VALUE
2D
(BODY)
1ST
SIGNIFICANT FIGURES
METHOD B
B
JAN COLOR CODE (FIXED, WIRE-WOUND: RU)
1ST
2D
SIGNIFICANT FIGURES
TOLERANCE
DOUBLE WIDTH
MULTIPLYING VALUE
C
JAN TYPE DESIGNATIONS (FIXED COMPOSITION)
RC
30
AE
153
M
1ST SIG FIGURE
MULTIPLIER
STYLE
2D SIG FIGURE
RESISTANCE
COMPONENT
CHARACTERISTIC
TOLERANCE
JAN TYPE DESIGNATIONS (FIXED, WIRE-WOUND)
RW
40
G
102
1ST SIG FIGURE
MULTIPLIER
STYLE
2D SIG FIGURE
RESISTANCE
COMPONENT
CHARACTERISTIC
D

STANDARDS				
COLOR	SIGNIFICANT FIGURE	MULTIPLYING VALUE	TOLERANCE (%)	JAN LETTER TOLERANCE
BLACK	0	1	—	—
BROWN	1	10	±1	F
RED	2	100	±2	G
ORANGE	3	1,000	±3	—
YELLOW	4	10,000	±4	—
GREEN	5	100,000	±5	—
BLUE	6	1,000,000	±6	—
VIOLET	7	10,000,000	±7	—
GRAY	8	100,000,000	±8	—
WHITE	9	1,000,000,000	±9	—
GOLD	—	0.1	±5	J
SILVER	—	0.01	±10	K
NO COLOR	—	—	±20	M

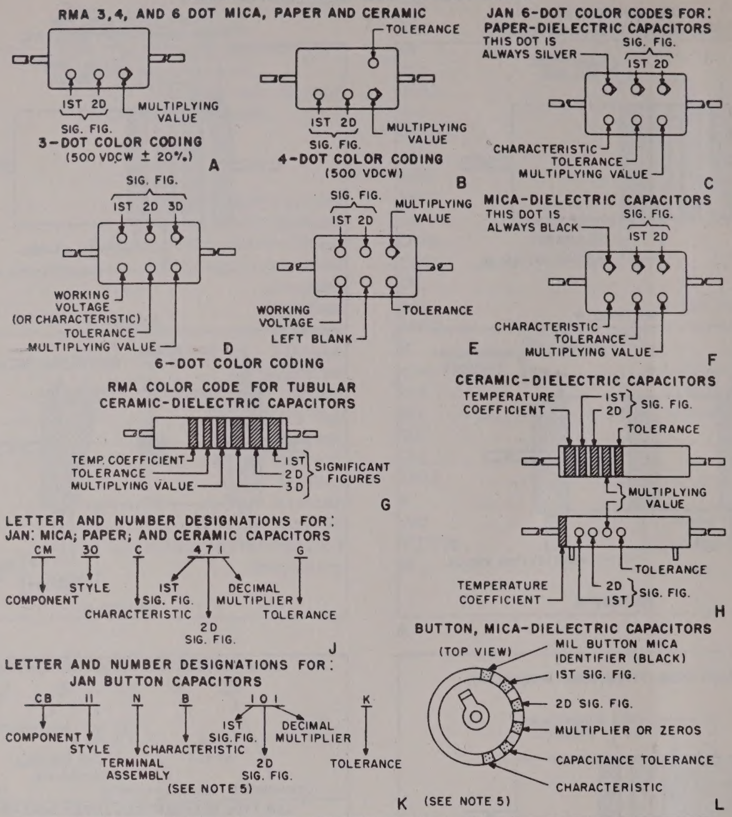
NOTES:

1. RESISTORS WITH AXIAL LEADS ARE INSULATED RESISTORS WITH RADIAL LEADS ARE NON-INSULATED.
2. RMA: RADIO MANUFACTURERS ASSOCIATION.
3. JAN: JOINT ARMY-NAVY.
4. THESE COLOR AND NUMBER CODES GIVE ALL RESISTANCE VALUES IN OHMS.
5. RESISTIVE COMPONENTS USED FOR LETTER TOLERANCES ARE: RC, RN, AND RU.
6. WATTAGE FOR RW TYPES IS FOUND IN THE JAN SPECIFICATIONS UNDER CHARACTERISTICS.

TMRC

Figure 40. Resistor color codes.

CAPACITOR COLOR AND LETTER CODES


RMA 3, 4, AND 6 DOT MICA, PAPER AND CERAMIC
1ST 2D
SIG. FIG.
MULTIPLYING VALUE
3-DOT COLOR CODING
(500 VDCW ± 20%)
A
TOLERANCE
1ST 2D
SIG. FIG.
MULTIPLYING VALUE
4-DOT COLOR CODING
(500 VDCW)
B
JAN 6-DOT COLOR CODES FOR:
PAPER-DIELECTRIC CAPACITORS
THIS DOT IS ALWAYS SILVER
SIG. FIG.
1ST 2D
CHARACTERISTIC
TOLERANCE
MULTIPLYING VALUE
C
SIG. FIG.
1ST 2D 3D
WORKING VOLTAGE (OR CHARACTERISTIC)
TOLERANCE
MULTIPLYING VALUE
D
6-DOT COLOR CODING
SIG. FIG.
1ST 2D
MULTIPLYING VALUE
WORKING VOLTAGE
LEFT BLANK
TOLERANCE
E
MICA-DIELECTRIC CAPACITORS
THIS DOT IS ALWAYS BLACK
SIG. FIG.
1ST 2D
CHARACTERISTIC
TOLERANCE
MULTIPLYING VALUE
F
RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS
TEMP. COEFFICIENT
TOLERANCE
MULTIPLYING VALUE
1ST
2D
3D
SIGNIFICANT FIGURES
G
CERAMIC-DIELECTRIC CAPACITORS
TEMPERATURE COEFFICIENT
1ST
2D
SIG. FIG.
TOLERANCE
MULTIPLYING VALUE
TOLERANCE
TEMPERATURE COEFFICIENT
2D
1ST
SIG. FIG.
H
LETTER AND NUMBER DESIGNATIONS FOR: JAN: MICA; PAPER; AND CERAMIC CAPACITORS
CM 30 C 471 G
COMPONENT
STYLE
CHARACTERISTIC
1ST SIG. FIG.
2D SIG. FIG.
DECIMAL MULTIPLIER
TOLERANCE
J
LETTER AND NUMBER DESIGNATIONS FOR: JAN BUTTON CAPACITORS
CB 11 N B 101 K
COMPONENT
STYLE
TERMINAL ASSEMBLY
CHARACTERISTIC
1ST SIG. FIG.
2D SIG. FIG.
DECIMAL MULTIPLIER
TOLERANCE
(SEE NOTE 5)
K
BUTTON, MICA-DIELECTRIC CAPACITORS
(TOP VIEW)
MIL BUTTON MICA IDENTIFIER (BLACK)
1ST SIG. FIG.
2D SIG. FIG.
MULTIPLIER OR ZEROS
CAPACITANCE TOLERANCE
CHARACTERISTIC
(SEE NOTE 5)
L

- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
										CAP. TOL. FOR MORE THAN 10 UUF		CAP. TOL. FOR 10 UUF OR LESS		
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARACTERISTIC	LETTER TOL.	CHARACTERISTIC	DEC. MULT.	%	LETTER DESIGNATION	UUF	LETTER DESIGNATION	CHARACTERISTIC
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C.
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	± 5	500	-	F	-	R	-	± 5	J	±0.5	D	S
BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-		±20	500	-	-	-	-	-	-	-	-	-	-

* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%

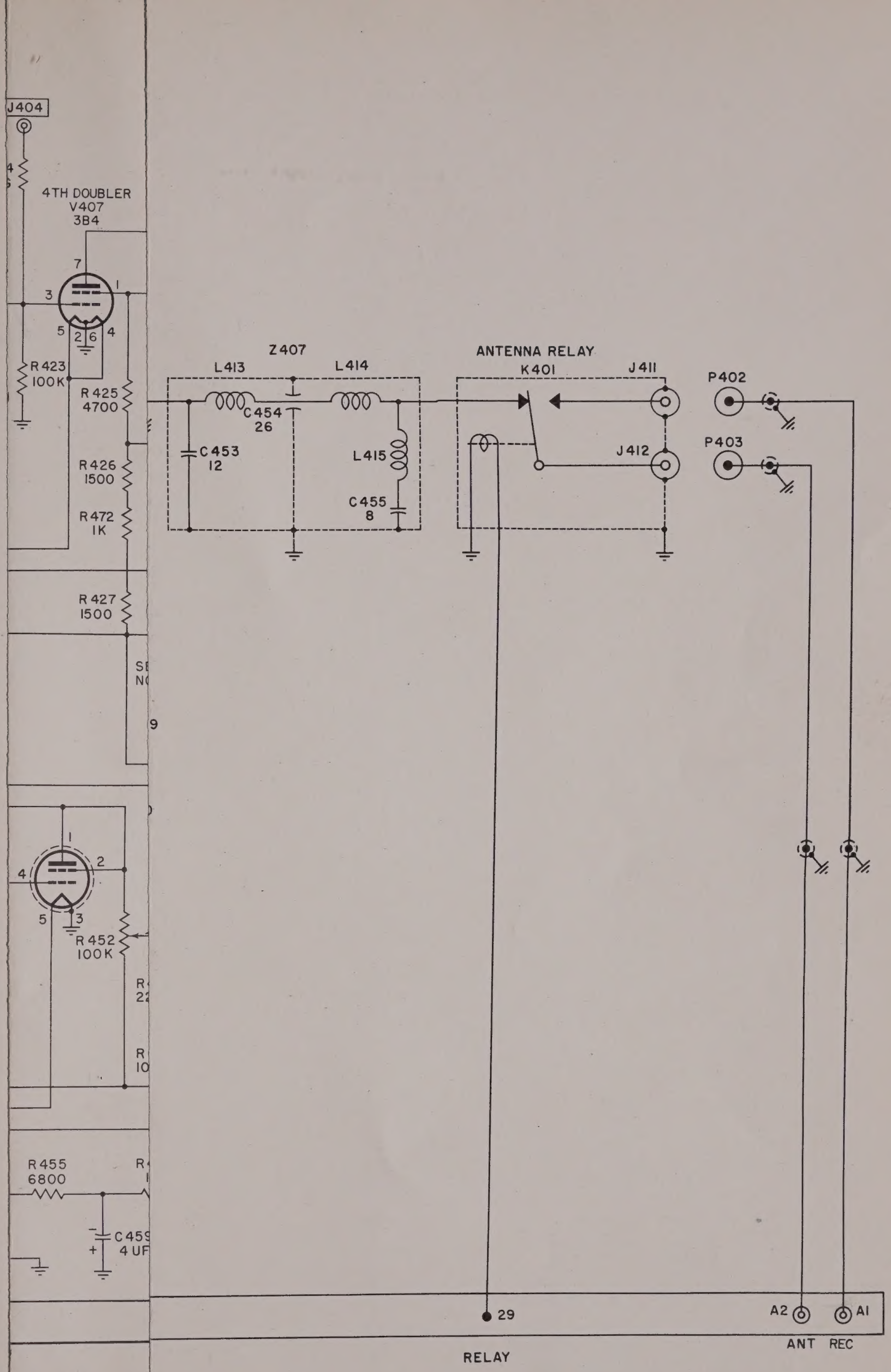
NOTES

JAN: JOINT ARMY-NAVY
RMA: RADIO MANUFACTURERS ASSOCIATION

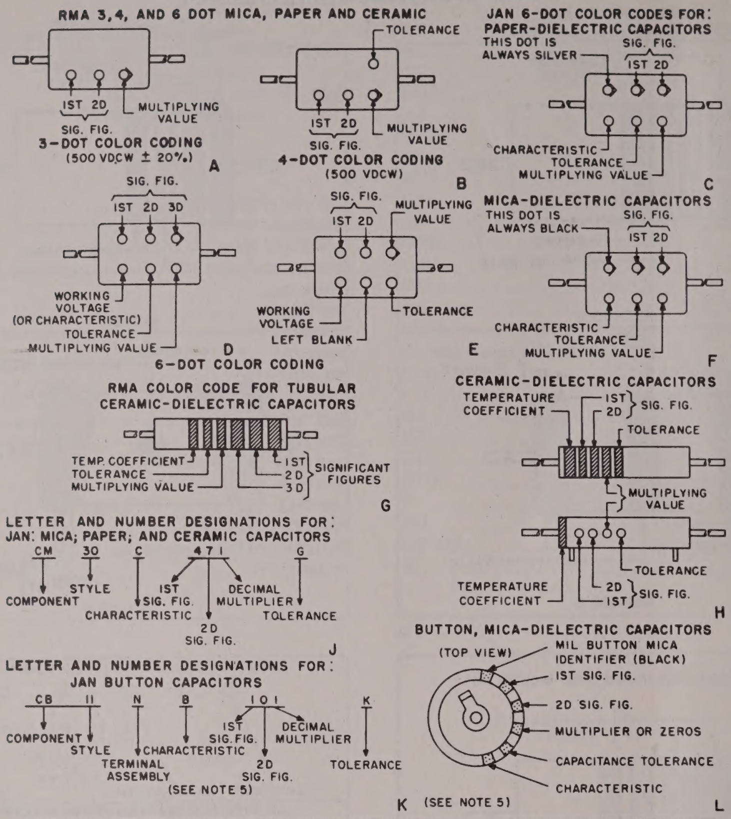
1. THESE COLOR AND LETTER CODES GIVE CAPACITANCES IN MICROMICROFARADS
2. THIS TABLE IS ADAPTED FOR JAN AND RMA COLOR AND JAN LETTER TYPE DESIGNATIONS
3. CERAMIC AND MICA CAPACITORS, BOTH JAN AND RMA, ARE GENERALLY 500 VDCW
4. BUTTON CAPACITORS ARE GENERALLY 300 VDCW
5. READ BUTTON CAPACITOR TOLERANCE UNDER CERAMICS OF MORE THAN 10 UUF
6. CHARACTERISTICS ARE AVAILABLE IN JAN CAPACITOR SPECIFICATION MANUALS
7. THE COMPONENTS USED ABOVE FOR JAN LETTER TYPE DESIGNATIONS ARE:
   CB MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

TM CC

Figure 41. Capacitor color codes.


J404
4TH DOUBLER
V407
3B4
R423
100K
R425
4700
R426
1500
R472
1K
R427
1500
9
R452
100K
R455
6800
C459
4 UF
Z407
L413
L414
C454
26
C453
12
L415
C455
8
ANTENNA RELAY
K401
J411
J412
P402
P403
29
RELAY
A2
A1
ANT
REC

CAPACITOR COLOR AND LETTER CODES


RMA 3,4, AND 6 DOT MICA, PAPER AND CERAMIC
IST 2D
MULTIPLYING VALUE
SIG. FIG.
3-DOT COLOR CODING
(500 VDCW ± 20%)
A
TOLERANCE
IST 2D
MULTIPLYING VALUE
SIG. FIG.
4-DOT COLOR CODING
(500 VDCW)
B
JAN 6-DOT COLOR CODES FOR:
PAPER-DIELECTRIC CAPACITORS
THIS DOT IS ALWAYS SILVER
SIG. FIG.
IST 2D
CHARACTERISTIC
TOLERANCE
MULTIPLYING VALUE
C
SIG. FIG.
IST 2D 3D
WORKING VOLTAGE (OR CHARACTERISTIC)
TOLERANCE
MULTIPLYING VALUE
D
SIG. FIG.
IST 2D
MULTIPLYING VALUE
WORKING VOLTAGE
LEFT BLANK
TOLERANCE
E
6-DOT COLOR CODING
MICA-DIELECTRIC CAPACITORS
THIS DOT IS ALWAYS BLACK
SIG. FIG.
IST 2D
CHARACTERISTIC
TOLERANCE
MULTIPLYING VALUE
F
RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS
TEMP. COEFFICIENT
TOLERANCE
MULTIPLYING VALUE
IST
2 D
3 D
SIGNIFICANT FIGURES
G
CERAMIC-DIELECTRIC CAPACITORS
TEMPERATURE COEFFICIENT
IST
2D
SIG. FIG.
TOLERANCE
MULTIPLYING VALUE
TOLERANCE
TEMPERATURE COEFFICIENT
2D
IST
SIG. FIG.
H
LETTER AND NUMBER DESIGNATIONS FOR: JAN: MICA; PAPER; AND CERAMIC CAPACITORS
CM 30 C 471 G
COMPONENT
STYLE
CHARACTERISTIC
IST SIG. FIG.
2D SIG. FIG.
DECIMAL MULTIPLIER
TOLERANCE
J
LETTER AND NUMBER DESIGNATIONS FOR: JAN BUTTON CAPACITORS
CB 11 N B 101 K
COMPONENT
STYLE
TERMINAL ASSEMBLY
CHARACTERISTIC
IST SIG. FIG.
2D SIG. FIG.
DECIMAL MULTIPLIER
TOLERANCE
(SEE NOTE 5)
K
BUTTON, MICA-DIELECTRIC CAPACITORS
(TOP VIEW)
MIL BUTTON MICA IDENTIFIER (BLACK)
IST SIG. FIG.
2D SIG. FIG.
MULTIPLIER OR ZEROS
CAPACITANCE TOLERANCE
CHARACTERISTIC
(SEE NOTE 5)
L

- STANDARDS -					JAN MICA-CM		JAN PAPER-CN		JAN CERAMIC-CC					
										CAP. TOL. FOR MORE THAN 10 UUF		CAP. TOL. FOR 10 UUF OR LESS		
COLOR	SIG. FIG.	DECIMAL MULTIPLIER	% TOL.	VDCW	LETTER TOL.	CHARACTERISTIC	LETTER TOL.	CHARACTERISTIC	DEC. MULT.	%	LETTER DESIGNATION	UUF	LETTER DESIGNATION	CHARACTERISTIC
BLACK	0	1	±20	500	M	A	M	A	1	±20	M	±2.0	G	C
BROWN	1	10	± 1	100	-	B	-	E	10	± 1	F	-	-	H
RED	2	100	± 2	200	G	C	-	H	100	± 2	G	-	-	L
ORANGE	3	1,000	± 3	300	-	D	N*	J	1,000	-	-	-	-	P
YELLOW	4	10,000	± 4	400	-	E	-	P	-	-	-	-	-	R
GREEN	5	100,000	± 5	500	-	F	-	R	-	± 5	J	±0.5	D	S
BLUE	6	1,000,000	± 6	600	-	G	-	S	-	-	-	-	-	T
VIOLET	7	10,000,000	± 7	700	-	-	-	T	-	-	-	-	-	U
GRAY	8	100,000,000	± 8	800	-	-	-	-	0.01	-	-	±0.25	C	B
WHITE	9	1,000,000,000	± 9	900	-	-	-	-	0.1	± 10	K	±1.0	F	SL
GOLD	-	0.1	± 5	1,000	J	-	-	-	-	-	-	-	-	A
SILVER	-	0.01	±10	2,000	K	-	K	-	-	-	-	-	-	-
NO COLOR	-		±20	500	-	-	-	-	-	-	-	-	-	-

* THE TOLERANCE OF THIS CAPACITOR IS ±30%, NOT ±3%

NOTES

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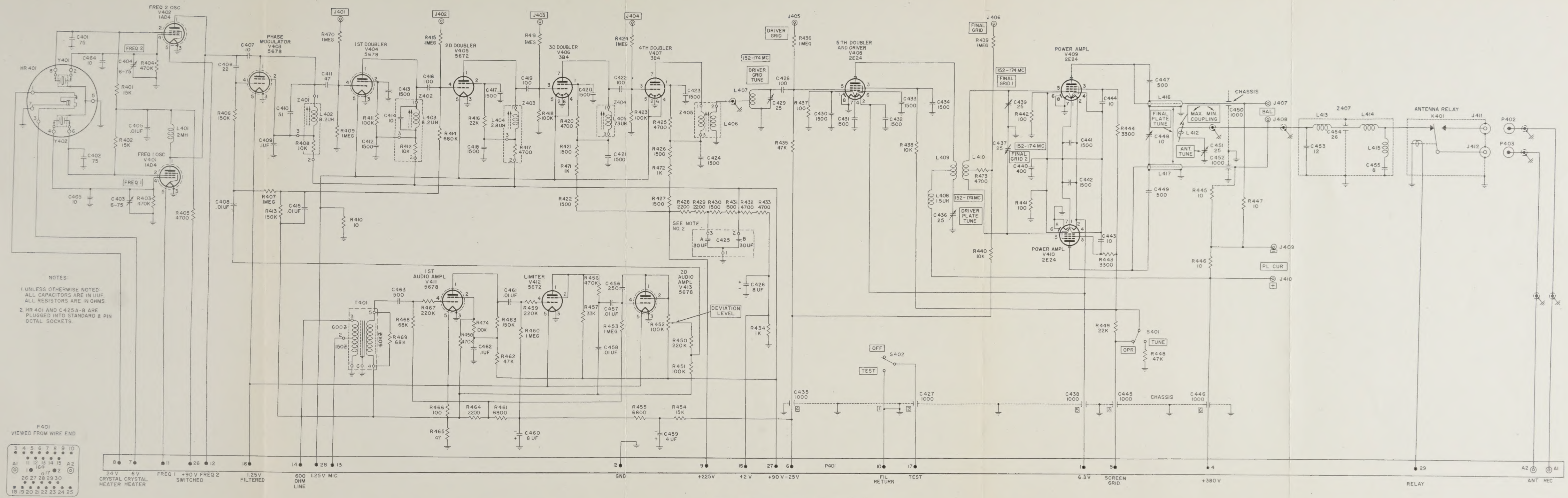
   CP MICA BUTTON: *CC* CERAMIC; *CM* MICA MOULDED: *CN* PAPER MOULDED

TM CC

Figure 41. Capacitor color codes.


FREQ 2 OSC V402 1AD4
FREQ 1 OSC V401 1AD4
HR 401
Y401
Y402
FREQ 2
FREQ 1
PHASE MODULATOR V403 5678
1ST DOUBLER V404 5678
2D DOUBLER V405 5672
3D DOUBLER V406 3B4
4TH DOUBLER V407 3B4
5TH DOUBLER AND DRIVER V408 2E24
POWER AMPL V409 2E24
POWER AMPL V410 2E24
J401
J402
J403
J404
J405
J406
DRIVER GRID
DRIVER GRID TUNE
152-174 MC
FINAL GRID
FINAL GRID 1
FINAL GRID 2
DRIVER PLATE TUNE
FINAL PLATE TUNE
MAX. MIN. COUPLING
ANT TUNE
CHASSIS
BAL
J407
J408
J409
J410
PL CUR
Z407
ANTENNA RELAY K401
J411
J412
P402
P403
SEE NOTE NO. 2
1ST AUDIO AMPL V411 5678
LIMITER V412 5672
2D AUDIO AMPL V413 5678
T401
DEVIATION LEVEL
S401
OPR
TUNE
S402
OFF
TEST
P401
P401 VIEWED FROM WIRE END
24 V CRYSTAL HEATER
6 V CRYSTAL HEATER
FREQ 1
+90 V SWITCHED
FREQ 2
1.25 V FILTERED
600 OHM LINE
1.25 V MIC
GND
+225 V
+2 V
+90 V-25 V
FIL RETURN
TEST
6.3 V
SCREEN GRID
+380 V
RELAY
ANT
REC

NOTES:

1. UNLESS OTHERWISE NOTED ALL CAPACITORS ARE IN UUF. ALL RESISTORS ARE IN OHMS.
2. HR 401 AND C425A-B ARE PLUGGED INTO STANDARD 8 PIN OCTAL SOCKETS.

Figure 42. Radio Transmitter T-278/U, schematic diagram.

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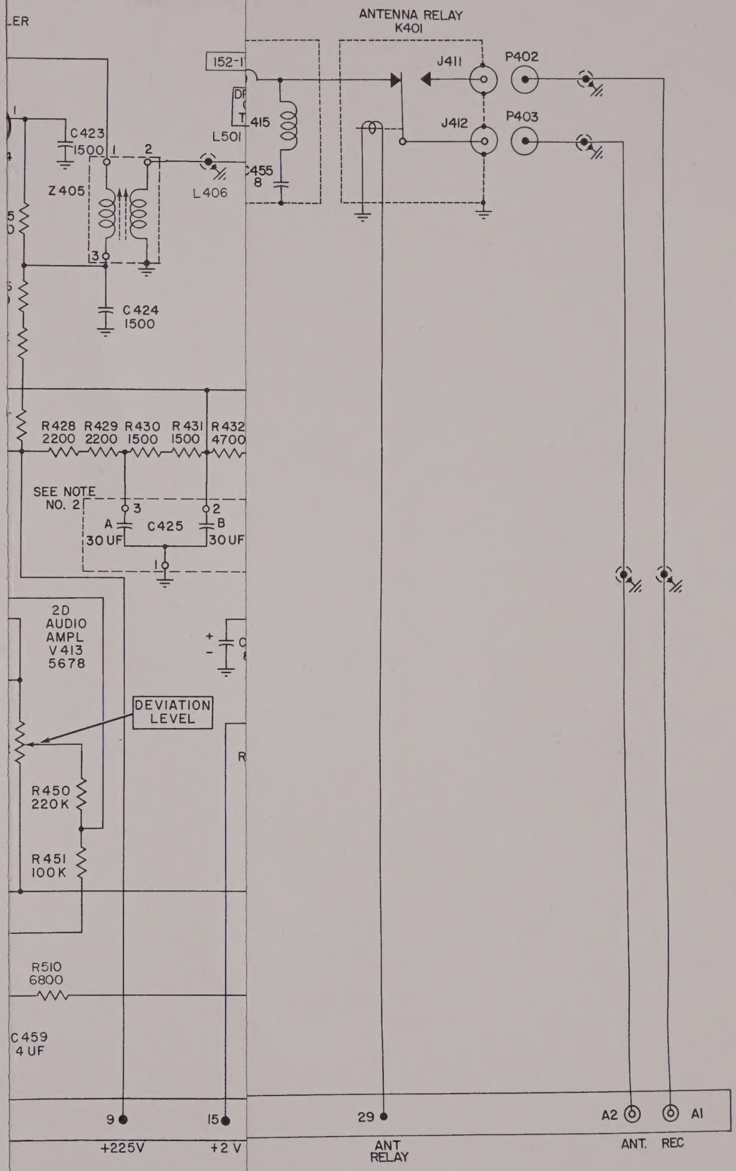
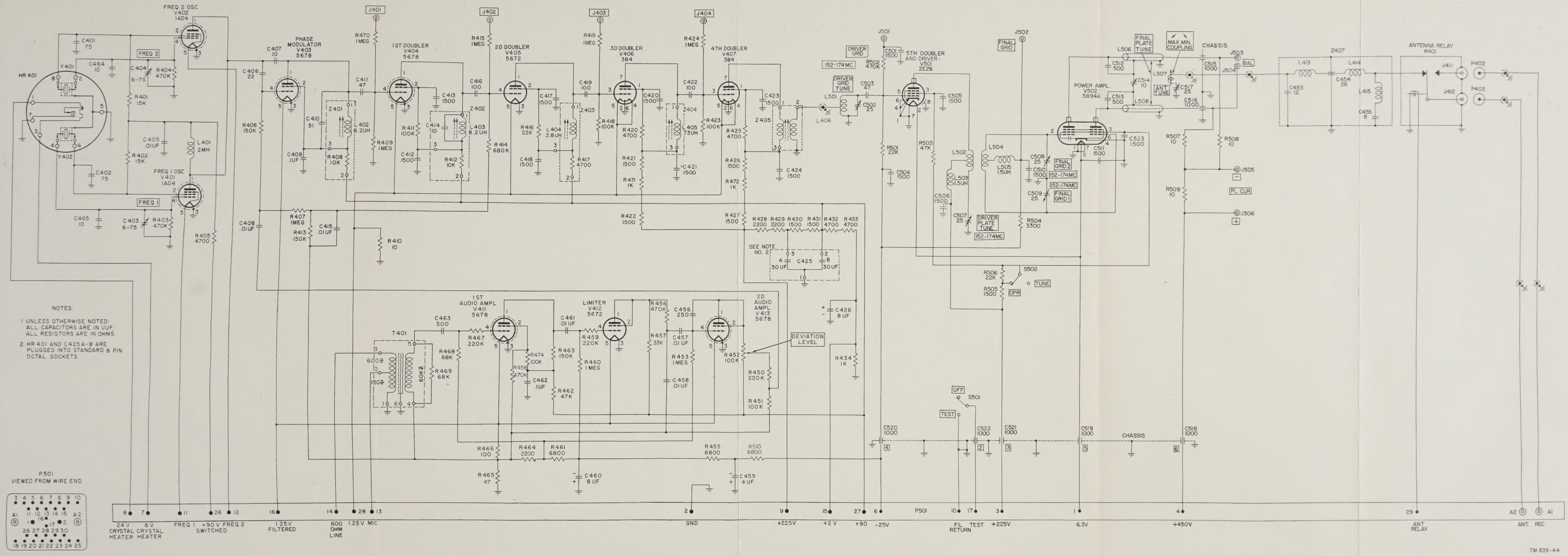

LER
ANTENNA RELAY
K401
152-1
DF
T
415
L501
C455
8
J411
J412
P402
P403
1
C423
1500
1
2
Z405
L406
3
C424
1500
R428
2200
R429
2200
R430
1500
R431
1500
R432
4700
SEE NOTE
NO. 2
3
2
A
C425
B
30 UF
30 UF
1
2D
AUDIO
AMPL
V413
5678
DEVIATION
LEVEL
R450
220K
R451
100K
R510
6800
C459
4 UF
9
15
29
A2
A1
+225V
+2 V
ANT
RELAY
ANT.
REC
TM 839-44

adio Transmitter T-416/GR, schem



FREQ 2 OSC
V402
1AD4
FREQ 1 OSC
V401
1AD4
HR 401
Y401
Y402
FREQ 2
FREQ 1
C401
75
C402
75
C403
6-75
C404
6-75
C405
.01UF
C464
10
C465
10
R401
15K
R402
15K
R403
470K
R404
470K
R405
4700
L401
2MH
PHASE
MODULATOR
V403
5678
C406
22
C407
10
C408
.01UF
C409
.1UF
C410
51
C411
47
Z401
L402
8.2UH
R406
150K
R407
1MEG
R408
10K
R409
1MEG
R410
10
R413
150K
C415
.01UF
J401
R470
1MEG
1ST DOUBLER
V404
5678
R411
100K
C412
1500
C413
1500
C414
10
Z402
L403
8.2UH
R412
10K
J402
R415
1MEG
R414
680K
C416
100
2D DOUBLER
V405
5672
R416
22K
C417
1500
C418
1500
Z403
L404
2.8UH
R417
4700
J403
R419
1MEG
C419
100
R418
100K
3D DOUBLER
V406
3B4
C420
1500
R420
4700
R421
1500
R471
1K
R422
1500
Z404
L405
.73UH
*C421
1500
J404
R424
1MEG
C422
100
R423
100K
4TH DOUBLER
V407
3B4
C423
1500
Z405
R425
4700
R426
1500
R472
1K
R427
1500
C424
1500
R428
2200
R429
2200
R430
1500
R431
1500
R432
4700
R433
4700
SEE NOTE
NO. 2
C425
A
30 UF
B
30 UF
L406
DRIVER
GRID
152-174MC
DRIVER
GRID
TUNE
L501
C502
25
C503
47
J501
C501
1500
R502
470K
5TH DOUBLER
AND DRIVER
V501
2E26
C505
1500
R501
22K
C504
1500
R503
47K
L502
L503
1.5UH
C506
1500
C507
25
DRIVER
PLATE
TUNE
152-174MC
J502
FINAL
GRID
L504
L505
1.5UH
C508
25
C510
1500
FINAL
GRID 2
152-174MC
152-174MC
C509
25
FINAL
GRID 1
R504
3300
POWER AMPL
V502
5894A
C511
1500
C523
1500
C512
500
C513
500
C514
10
L506
L507
L508
FINAL
PLATE
TUNE
MAX. MIN.
COUPLING
ANT
TUNE
C517
25
CHASSIS
C515
1000
C516
1000
J503
J504
BAL
R507
10
R508
10
R509
10
J505
−
PL CUR
J506
+
R506
22K
R505
1500
S502
TUNE
OPR
Z407
L413
L414
C453
12
C454
26
L415
C455
8
ANTENNA RELAY
K401
J411
J412
P402
P403
1ST
AUDIO AMPL
V411
5678
T401
600Ƶ
150Ƶ
60KƵ
C463
500
R467
220K
R468
68K
R469
68K
R474
100K
R458
470K
C462
.1UF
R466
100
R465
47
R464
2200
R461
6800
C460
8 UF
C461
.01 UF
R463
150K
R462
47K
LIMITER
V412
5672
R459
220K
R460
1 MEG
R456
470K
R457
33K
C456
250
C457
.01 UF
R453
1MEG
C458
.01 UF
2D
AUDIO
AMPL
V413
5678
R452
100K
DEVIATION
LEVEL
R450
220K
R451
100K
R455
6800
R510
6800
C459
4 UF
C426
8 UF
R434
1K
OFF
S501
TEST
C520
1000
C522
1000
C521
1000
C519
1000
CHASSIS
C518
1000
P501
VIEWED FROM WIRE END
A1
A2
24 V
CRYSTAL
HEATER
6 V
CRYSTAL
HEATER
FREQ 1
+90 V
SWITCHED
FREQ 2
1.25V
FILTERED
600
OHM
LINE
1.25V
MIC
GND
+225V
+2 V
+90
-25V
P501
FIL
RETURN
TEST
+225V
6.3V
+450V
ANT
RELAY
ANT.
REC
TM 839-44

NOTES:

1 UNLESS OTHERWISE NOTED:
ALL CAPACITORS ARE IN UUF.
ALL RESISTORS ARE IN OHMS.

2. HR 401 AND C425 A-B ARE PLUGGED INTO STANDARD 8 PIN OCTAL SOCKETS.

Figure 43. Radio Transmitter T-416/GR, schematic diagram.

APPENDIX II

IDENTIFICATION TABLE OF PARTS

1. Requisitioning Parts

The fact that a part is listed in this table is not sufficient basis for requisitioning the item. Requisitions must cite an authorized basis, such as a specific T/O&E, T/A, SIG 7&8, list of allowances of expendable material, or another authorized supply basis. The department of the Army Supply Catalog applicable to the equipment covered in this manual is SIG 7&8-T-278/U, and SIG 7&8-T-416/GR. For an index of available supply catalogs in the Signal portion of the Department of the Army Supply Catalog, see the latest issue of SIG 1, Introduction and Index.

2. Identification Table of Parts for T-278/U

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
	TRANSMITTER, radio: 152 to 174 mc range, 1 band; xtal controlled; 30 W; 380 v dc, .180 amp; 225 w dc, .070 amp; 200 w dc, .020 amp; 24 v dc, .25 amp; -22 v dc; .005 amp; 6.3 v dc, 2.0 amp; 6 v dc, .9 amp; 2 v dc, .01 amp; 1.3 v dc, .100 amp; 1.25 v dc, .9 amp; 1.25 v dc, .200 amp; 14-1/2 in. lg x 4-1/2 in. wd x 8-9/16 in. h o/a; Motorola Inc, Radio Transmitter T-278( )/U.	Radio transmitter for radio sets AN/VRC-19X, 19Y, and 19Z.	2C6900-278
H450, H451	BAR, shorting: phosphor bronze silver plarhodium pl; 1-11/32 in. lg x 3/8 in. wd x 1/32 in. thk.	H450: Final tank assembly tuning. H451: Balances plate load at final.	2Z558-83
TB401	BOARD, terminal: phenolic; 34 term.; 5-3/8 in. lg x 1-1/2 in. wd x 9/32 in. h.	Terminal board.	3Z770-34.26
TB402	BOARD, terminal: phenolic; 34 term.; 5-3/8 in. lg x 1-1/2 in. wd x 9/32 in. h.	Terminal board.	3Z770-34.27
TB403	BOARD, terminal: phenolic; 16 term.; 4 in. lg x 1-15/16 in. wd x 15/32 in. h.	Terminal board.	3Z770-16.84
TB404	BOARD, terminal: phenolic; 16 term.; 4 in. lg x 1-15/16 in. wd x 15/32 in. h.	Terminal board.	3Z770-16.85
TB405, E406	BOARD, terminal: plastic; 3 term.; 1-5/8 in. lg x 3/8 in. wd x 1/16 in. thk excluding term.	Mount miscellaneous electrical components.	3Z770-3.104
TB407	BOARD, terminal: phenolic; 11 term.; 3 in. lg x 1 in. wd x .062 in. thk excluding term.	Test point assembly.	3Z770-11-39
A407, A408	BRACKET: L shape; steel, cad pl and chromate finish; 2-1/8 in. lg x 3/8 in. wd x 9/16 in. d; mts by one 3/16 in. hole 7/32 in. from small end.	Support one end of terminal boards TB403 and TB404.	2Z1239.371

2. Identification Table of Parts for T-278/U (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps Stock No.
H449	BUSHING: 1.000 in. o/a lg, .312 in. dia across flats, bushing thd thru ctr w/8-32 thd, 1/4 in. lg bushing thd ext w/1/4-32 thd.	Part of final plate tuner assembly.	2Z1409-340
C401, C402	CAPACITOR, fixed: ceramic; 75 uuf ±10%; 500 vdcw.	C401: V402 screen grid feedback. C402: V401 screen grid feedback.	3D9047-75
C405	CAPACITOR, fixed: ceramic, 10,000 uuf +100% -0; 500 vdcw.	V401 screen and plate decoupling.	3DA10-562
C406	CAPACITOR, fixed: ceramic; 22 uuf ±10%; 500 vdcw.	V403 plate to control grid coupling.	3D9022-65
C407	CAPACITOR, fixed: ceramic; 10 uuf ±1 uuf; 500 vdcw.	V403 plate to control grid coupling.	3D9010-226
C410	CAPACITOR, fixed: ceramic; 51 uuf ±10%; 500 vdcw.	V404 control grid d-c blocking.	3D9051-82
C411	CAPACITOR, fixed: ceramic; 47 uuf ±10%; 500 vdcw.	V404 control grid d-c blocking.	3D9047-79
C412, C413, C417, C418, C420, C421, C423, C424, C430, thru C434, C442, C441	CAPACITOR, fixed: ceramic; 1500 uuf +100% -0; 500 vdcw.	C412: V404 plate and screen grid decoupling. C413: V404 screen grid bypass. C417: V405 screen grid bypass. C418: V405 plate and screen grid bypass. C420: V406 screen grid bypass. C421: V406 plate and screen grid bypass. C423: V407 screen grid bypass. C424: V407 plate and screen grid bypass. C430, C431, C432, and C433: V408 filament bypass. C434: V408 screen grid bypass. C442 and C441: V409 and V410 filament bypass.	3DA1.500-70
C414	CAPACITOR, fixed: ceramic; 10 uuf ±.25 uuf 500 vdcw.	Part of Z402 network.	3D9010-227
C416, C419, C422, C428	CAPACITOR, fixed: ceramic; 100 uuf ±10%; 500 vdcw.	C416: V405 control grid d-c blocking. C419: V406 control grid d-c blocking.	3D9100-341

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		C422: V407 control grid d-c blocking. C428: V408 control grid d-c blocking.	
C427, C435, C438, C445, C446, C450, C452	CAPACITOR, fixed: ceramic; 1000 uuf ±20%; 750 vdcw.	C427: S402 bypass. C435: V408, V409, and V410 control grid bypass. C438: V408, V409, and V410 filament bypass. C445: V408, V409, and V410 screen grid bypass. C446: V409 and V410 plate bypass. C450: RF bypass at L416. C452: RF bypass at L417.	3DA1-370
C443, C444	CAPACITOR, fixed: ceramic; 10 uuf ±1 uuf; 500 vdcw.	C443: V401 screen grid-to-filament bypass. C444: V402 screen grid-to-filament bypass.	3D9010-232
C447, C448	CAPACITOR, fixed: ceramic; 500 uuf +100% -0; 750 vdcw.	C447: V409 plate bypass capacitor. C448: V410 plate bypass capacitor.	3D9500-284
C453	CAPACITOR, fixed: ceramic; 12 uuf ±10%; 500 vdcw.	Part of Z407 network.	3D9012-88
C454	CAPACITOR, fixed: ceramic; 26 uuf ±10%; 500 vdcw.	Part of Z407 network.	3D9026-1
C455	CAPACITOR, fixed: ceramic; 8 uuf ±1%; 500 vdcw.	Part of Z407 network.	3D9008-52
C425	CAPACITOR, fixed: electrolytic; 2 sect.; 30 uf sect.; 400 vdcw.	V406 and V407 screen grid voltage filter.	3DB30-58
C426, C460	CAPACITOR, fixed: electrolytic; 8 uf; 30 vdcw.	C426: +2-volt microphone line filter. C460: Part of filter on -25-volt line.	3DB8-240
C459	CAPACITOR, fixed: electrolytic; 4 uf; 60 vdcw.	Negative 25-volt bias filter.	3DB4-412
C456	CAPACITOR, fixed: mica; 240 uuf ±5%; 500 vdcw.	V413 plate-to-control grid bypass.	3D9240-33
C463	CAPACITOR, fixed: mica; 510 uuf ±5%; 300 vdcw.	V411 d-c blocking.	3D9510-38
C408, C415, C457, C458, C461	CAPACITOR, fixed: paper; 10,000 uuf ±20%; 200 vdcw.	C408: Couples plate of V413 to control grid of V403. C415: Part of antenna filter assembly Z407.	3DA10-625

2. Identification Table of Parts for T-278/U (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		C457: Couples plate of V412 to control grid of V413. C458: D-c blocking capacitor for test jack J402. C461: Couples plate of V411 to grid of V412.	
C409, C462	CAPACITOR, fixed: paper; 100,000 uuf ±20%; 200 vdcw.	C409: Screen grid bypass capacitor for V403. C462: Plate and screen decoupling capacitor for V411.	3DA100-1172
C403, C404	CAPACITOR, variable: air; plate meshing type; 75 uuf max, 6 uuf min; 850v a-c peak; 1-1/2 in. lg x 15/16 in. wd x 1-7/32 in. h; screw driver adj, continuous rotation.	C403: Y401 crystal resonance control. C404: Y402 crystal resonance control.	3D9075V-33
C429, C409	CAPACITOR, variable: air; plate meshing type; 23 uuf max, 4 uuf min; 600 v a-c peak; 1-1/16 in. lg x 15/16 in. wd x 1-7/32 in. h; scdr adj, continuous rotation.	C429: driver grid tuning. C409: V409 grid tuning.	3D9023V-8
C436	CAPACITOR, variable: air; 23 uuf max, 4.5 uuf min; 1200 v a-c peak; 1-1/4 in. lg x 15/16 in. wd x 1-7/32 in. h; scdr adj; continuous rotation.	Driver plate tuning.	3D9023V-16
C451	CAPACITOR, variable: air; plate meshing type; 23 uuf max, 4 uuf min; 600 v a-c peak; 1-1/16 in. lg x 15/16 in. wd x 1-7/32 in. h.	Antenna coupler tuning.	3D9023V-5
H497	CLAMP, electrical: 49/64 in. lg x 1/2 in. wd x 5/16 in. h; accom material up to 3/16 in. dia.	Cable clamp.	8P1-101-2
H440, H441	CLAMP, electrical: ethyl cellulose acetate; 13/16 in. lg x 1/2 in. wd x 5/16 in. h; accom material up to 1/4 in. max dia.	Cable clamps.	8P1-101-1
E416	CLIP, electrical: 1/2 in. lg x 3/8 in. wd x 3/8 in. h.	Plate connector for V410 tube.	2Z2712.386
E417, E428	CLIP, electrical: 1/2 in. lg x 3/8 in. wd x 3/8 in. h.	E417: Plate connector for V409 tube. E428: Plate connector for V408 tube.	2Z2712.387
H480 thru H487	CLIP, electrical: 1-11/32 in. lg x 5/8 in. wd o/a, x 5/32 in. thk across flats.	Hold tube in place.	2Z2712.381
E421	COIL, RF: #14 AWG, copper cond, wnd, air core, 1-7/8 in. lg x 19/32 in. wd.	Couples transmitter output to antenna.	3C1084B-89

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
L401	COIL, RF: 2 mh at 250 kc, 25 ohms d-c resistance; 430 turns, #38 AWG, one wnd, single pie wnd; 15/32 in. lg x 9/32 in. dia.	Oscillator plate load coil.	3C1084B-88
L407	COIL, RF: 4 turns, #16 AWG, one wnd, 2.500 in. lg x .477 in. dia.	Part of V408 1-c tuned grid circuit.	3C1084B-106
L408, L411	COIL, RF: 30 turns, #26 AWG, air core, 5/8 in. lg x 3/16 in. dia.	L408: Plate choke for V408. L411: V409 and V410 control grid choke.	3C362-101
L409	COIL, RF: #10 AWG, one wnd, air form, 3.781 in. lg x 1.265 in. wd x 2.750 in. d.	Part of V408 plate coupling circuit.	3C1084B-105
L410	COIL, RF: #10 AWG, one wnd, air form, 2.437 in. lg x .704 in. wd x .102 in. thk.	Part of V409 control grid coupling circuit.	3C1084B-104
L413	COIL, RF: 6 turns, #18 AWG, copper cond, one wnd, .258 in. OD approx, .937 in. lg.	Part of antenna input network Z407.	3C1084B-87
L414	COIL, RF: 5 turns, #18 AWG, copper cond, one wnd, .267 in. OD x .937 in. lg.	Part of antenna input network Z407.	3C1084B-86
L415	COIL, RF: 3 turns, #18 AWG, copper cond, one wnd, .290 in. OD x .789 in. lg.	Part of antenna input network Z407.	3C1084B-85
Z401	COIL, RF: 8.2 uh at 7.9 mc, 1.1 ohms d-c resistance; 60 turns, #34 AWG, copper cond, one wnd, powdered-iron core; 1.593 in. lg x .263 in. dia approx.	V403 plate load.	3C1084B-82
Z402	COIL, RF: 8.2 uh at 7.9 mc, 1.1 ohms d-c resistance; 60 turns, #34 AWG, copper cond, powdered-iron core; contains one RC10BF103K resistor and one CC20PH100F capacitor.	V404 plate load.	3C1084B-80
Z403	COIL, RF: 2.8 uh at 7.9 mc, .33 ohms d-c resistance; 30 turns, #32 AWG, copper cond, powdered-iron core; contains one RC10BF472K resistor.	V405 plate load.	3C1084B-79
Z404	COIL, RF: .73 uh at 25 mc, .016 ohms d-c resistance; 13-1/2 turns, #22 AWG, copper cond, powdered-iron core.	V406 plate load.	3C1084B-81
P402	CONNECTOR, plug: male, round; 1-1/16 in. lg x 9/16 in. dia; 50 ohms nom impedance.	Coaxial connectors.	2Z7390-88
J401 thru J404	CONNECTOR, receptacle: female, round; 11/16 in. lg x 37/64 in. wd.	J401: Test point for control grid of V404. J402: Test point for control grid of V405. J403: Test point for control grid of V406. J404: Test point for control grid of V407.	2Z3055-38

2. Identification Table of Parts for T-278/U (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
P401	CONNECTOR, receptacle: male, round; 1-7/32 in. lg x 3-3/8 in. wd x 1-11/16 in. h; 28-10 amp, 2-40 amp, 2 coaxial, 2 amp, 110 v ac.	Connects transmitter to Case CY-938( )/VRC.	2Z3046.40
A414	COVER: aluminum alloy; 6-23/64 in. lg x 4-1/16 in. wd x 33/64 in. d.	Protective front cover and panel for transmitter.	2Z3351-540
H464, H465	FASTENER, spring lock: steel; 3/4 in. lg x 5/8 in. wd x 1/2 in. h o/a.	Hold cover in place.	6Z3810-16.20
E411 thru E415	INSULATOR, bushing: cylindrical shape.	Insulate positive plate of C440 from chassis.	3G100-311
E430	INSULATOR, plate: phenolic; rectangular shape; 3-3/4 in. lg x 1-5/16 in. wd x 1/32 in. thk.	Insulator for transmitter adjustment controls.	3G320-378
E410	INSULATION SHEET, electrical: 2.125 in. wd x 4.0 in. lg x .007 in. thk.	Dielectric for capacitor C440.	3G320-386
E420	INSULATOR, spacer: phenolic; rectangular shape; 11/16 in. lg x 3/8 in. h x 17/32 in. wd.	Insulates shorting bar.	3G335-44
E418, E419, E424, E425, E426	INSULATOR, standoff: steatite cylindrical pillar shape.	E418 and E419: Supports for plate line assembly. E424 and E425: Support for V408 plate line. E426: Support for grid line V409 and V410.	3G3501-04.2
E427	INSULATOR, standoff: steatite; cylindrical pillar shape.	Support for plate line V409 and V410.	3G3501-08
U401	INSULATOR, washer: neoprene; circular flat shape.	Insulation washer for plate line mounting bracket.	3G385-152
H442	KNOB: round; steel; .500 in. dia x .250 in. thk.	Part of lock in assembly.	2Z5822-807
L416, L417	LINE SECTION, RF: transmission; copper; L shaped; 2-31/32 in. lg x 1/4 in. dia x 4-1/4 in. h.	Parts of final tank circuit.	2Z10008-184
C440	MOUNTING: rectangular shape w/2 holes; 3.875 in. lg x 2.0 in. wd x 1/2 h o/a.	Plate for capacitor assembly and power amplifier tube sockets.	2Z6820.605
A404	MOUNTING, bracket: 1-5/8 in. lg x 1-1/16 in. wd x 1-17/32 in. h o/a approx.	Mounts output coupling link assembly.	2Z6820.591
A 411	MOUNTING, bracket: 1-13/16 in. h x 2-7/32 in. wd x 1-5/8 in. d.	Mounting bracket for V1801, V1802 plate transmission line.	2Z6820.593
A 405 A 406	MOUNTING, bracket: steel; 1.187 in. lg x .375 in. wd x .496 in. h approx o/a.	Mounting brackets for terminal boards TB2602 and TB2603.	2Z6820.594

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
HR401	OVEN, crystal: 75° C min oven temp, -40° C ambient temp, ±4° C; a-c 6.3 or 24 v, 60 cyc, single ph, 26 w; d-c 6.3 v or 24 v, 405 ma; aluminum case; 1-11/16 in. h x 1-1/4 in. dia.	Constant temperature crystal oven.	2Z6897-7
A 410	PANEL, control 4.115 ±.101 in. lg x 2.00 in. wd x .03125 in. thk; aluminum.	Test panel.	2Z6900-58
H443	PIN, dowel; corrosion resistant steel; .05 in. lg x .062 in. dia.	Fastens knurled nut to transmitter lock in assembly.	6L3961-1
H448	PIN, grooved: steel, copper-flash and nickel pl; cylindrical shape; 3/64 in. dia x 1/4 in. lg.	Pin for final tuning assembly adjusting screws.	6L3905-4
H452	PIN, wrist: brass, nickel pl; 1.125 in. lg x .252 dia max wd .250.	Connects adjusting feed screw to antenna coil.	6L3904-18
K401	RELAY, solenoid: normally closed, single break, d-c, 115 v, 2 amp: one wnd noninductive, d-c, 52-ohm resistance, 6 v dc, 111 ma; 2-15/16 in. lg x 2-3/8 in. wd x 1-1/4 in. h.	Antenna relay.	2Z7599A-450
R401, R402, R462	RESISTOR, fixed: comp; 47,000 ohms ±10%; 1/2 w.	R401 and R402: Parts of V401 and V402 input balance. R462: V411 plate voltage dropping.	3RC20BF473K
R403, R404, R411, R418, R423, R451, R474	RESISTOR, fixed: comp; 100,000 ohms ±10%; 1/2 w.	R403: V403 suppressor grid bypass. R404: V404 suppressor grid bypass. R411: V404 screen grid voltage dropping. R418: V406 control grid bleeder. R423: V407 control grid bleeder. R451: V413 screen and control grid voltage dropping. R474: V411 screen dropping.	3RC20BF104K
R405, R420, R425	RESISTOR, fixed: comp; 4,700 ohms ±10%; 1/2 w.	R405: V401 and V402 plate voltage dropping. R420: V406 screen grid voltage dropping. R425: V407 screen grid voltage dropping.	3RC20BF472K
R406, R413, R457, R463	RESISTOR, fixed: comp; 150,000 ohms ±10%; 1/2 w.	R406: V403 audio-input coupler. R413: V403 and V405 control grid bias dropping.	3RC20BF154K

2. Identification Table of Parts for T-278/U (contd)

Ref symbol	Name of part and description	Function of part	Signal Corps stock No.
		R457: V412 plate voltage dropping. R463: V411 plate voltage dropping.	
R407, R409, R415, R419, R424, R436, R439, R453, R460, R470	RESISTOR, fixed: comp; 1 meg ±10%; 1/2 w.	R407: V405 control grid bias. R409: V404 control grid bias. R415: J402 voltage dropping. R419: J403 voltage dropping. R424: J404 voltage dropping. R436: J405 voltage dropping. R439: J406 voltage dropping. R453: V413 feedback limiter. R460: V412 control grid bias. R470: J401 voltage dropping.	3RC20BF105K
R408 R412	RESISTOR, fixed: comp; 10,000 ohms ±10%; 1/2 w.	R408: Part of Z401 network. R412: Part of Z402 network.	3RC20BF103K
R410	RESISTOR, fixed: comp; 10 ohms ±10%; 1 w.	V404 filament control.	3RC30BF100K
R414	RESISTOR, fixed: comp; 680,000 ohms ±10%; 1/2 w.	V405 control grid bias.	3RC20BF684K
R416	RESISTOR, fixed: comp; 22,000 ohms ±10%; 1/2 w.	V405 screen grid voltage dropping.	3RC20BF223K
R417	RESISTOR, fixed: comp; 4700 ohms ±10%; 1/2 w.	Part of Z403 network.	3RC20BF472K
R421, R422, R426, R427, R430, R431	RESISTOR, fixed: comp; 1,500 ohms ±10%; 2 w.	R421 and R422: V406 screen grid voltage dropping resistors. R426 and R427: V407 screen grid bias voltage dropping resistors. R430 and R431: V406 and V407 screen grid bias voltage dropping resistors.	3RC42BF152K
R428, R429	RESISTOR, fixed: comp; 2,200 ohms ±10%; 2 w.	V406 and V407 screen-grid voltage dropping resistors.	3RC42BE222K
R432, R433	RESISTOR, fixed: comp; 4,700 ohms ±10%; 2 w.	V406 and V407 screen grid voltage dropping resistors.	3RC42BE472K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
R434	RESISTOR, fixed: comp; 1,000 ohms ±10%; 1 w.	+25-volt bleeder resistor.	3RC30BF102K
R435, R448	RESISTOR, fixed: comp; 47,000 ohms ±10%; 1 w.	R435: V408 control grid bias dropping resistor. R448: S401 load.	3RC30BF473K
R437, R441, R442	RESISTOR, fixed: comp; 100 ohms ±10%; 2 w.	R437: V408 cathode dropping. R441: V410 cahtode dropping. R442: V409 cathode dropping.	3RC42BE101K
R438	RESISTOR, fixed: comp; 10,000 ohms ±10%; 1 w.	V408 screen grid dropping.	3RC30BF103K
R440	RESISTOR, fixed: comp; 15,000 ohms ±10%; 1 w.	Power-amplifier control grids bias voltage dropping.	3RC30BF153K
R443, R444	RESISTOR, fixed: comp; 3300 ohms ±10%; 1 w.	R443: V410 screen-grid bias dropping. R444: V409 screen grid dropping.	3RC30BF332K
R445, R446, R447	RESISTOR, fixed: comp; 10 ohms ±5%; 1/2 w.	Final plate B+ dropping resistors at J409.	3RC20BF100J
R449	RESISTOR, fixed: comp; 22,000 ohms ±10%; 2 w.	S401 bleeder shunt.	3RC42BE223K
R450, R459, R467	RESISTOR, fixed: comp; 220,000 ohms ±10%; 1/2 w.	R450: V413 output dropping. R459: V412 control grid bias voltage dropping. R467: V411 control grid bias voltage dropping.	3RC20BF224K
R454	RESISTOR, fixed: comp; 15,000 ohms ±10%; 1/2 w.	-22v voltage dropping resistor at C459.	3RC20BF153K
R455, R461	RESISTOR, fixed: comp; 6,800 ohms ±10%; 1/2 w.	R455: -22v voltage dropping resistor at C459. R461: -22v voltage dropping resistor at C460.	3RC20BF682K
R456, R458	RESISTOR, fixed: comp; 470,000 ohms ±10%; 1/2 w.	R456: V413 control grid coupler. R458: V412 screen grid feedback limiter.	3RC20BF474K
R464	RESISTOR, fixed: comp; 3,300 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF332K
R465, R466	RESISTOR, fixed: comp; 100 ohms ±10%; 1/2 w.	V411 cathode voltage dropping resistors.	3RC20BF101K
R468, R469	RESISTOR, fixed: comp; 68,000 ohms ±10%; 1/2 w.	R468: V413 feedback control.	3RC20BF683K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		R469: T401 secondary impedance balance shunt.	
R471, R472	RESISTOR, fixed: comp; 1000 ohms ±10%; 2 w.	R471: V406 screen grid voltage dropping. R472: V407 screen grid voltage dropping.	3RC42BE102K
R452	RESISTOR, variable: comp; 100,000 ohms ±20%; 1/4 w.	Transmitter modulation deviation control.	3RY51057
H435 thru H438, H463, H468 thru H478	RETAINER, fastener stud: steel, cad pl; 1 in. lg x 33/64 in. wd x 3/16 in. thk.	Retainers for cover fastener stud.	6Z7852-9
H445, H446, H447, H455, H456, H457	RING, retainer: carbon steel cad pl .282 in. OD x .114 in. ID x .025 in. thk.	H445 thru H447: Final plate tuning shaft retaining rings. H455 thru H457: Antenna coupler adjusting screw retainers.	2Z7858-351
H454	RING, retainer: carbon spring steel, cad pl; .112 in. ID x 1/8 in. max OD x .010 in. thk.	Retaining ring for antenna coupler assembly.	2A3171.1-27
H488 thru H495	RING, retainer: brass; .460 in. lg x .264 in. wd x .012 in. thk o/a.	Hold tube sockets in chassis.	2Z7858-343
H444	SCREW, externally relieved body: steel; 8-32 thd; 5-1/2 in. nom lg.	Antenna tuning feed screw.	6L4768-88.31F
H467	SHAFT: steel; 3.547 in. lg x .146 in. dia max o/a.	Output coupling link tuning shaft.	2Z8203-751
O 401, O 403	SHAFT, coupling: brass, nickel pl; 3/4 in. lg x 1/2 in. dia.	Couple extension shaft to C436.	2Z8203-752
O 402, O 404	SHAFT: plastic; 1 in. lg x .253 in. dia max.	O 402: Extension shaft for C436. O 404: Extension shaft for C451.	2Z8203-753
E406	SHELL, electrical connector: brass; silver pl; cylindrical; .750 in. lg x .250 in. OD x .152 in. and .204 in. ID.	Conduit and grounding connection for r-f cable.	2Z8276-113
E404, E405	SHIELD, electron tube: copper or brass; cylindrical; .430 in. dia x 1-3/4 in. h; nickel pl.	Tube shields	2Z8304.276

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
XCH-425, XHR-401, XV408	SOCKET, electron tube: 8 cont; oval shape; molded phenolic or thermosetting; mts above chassis.	XCH425: C425 condenser sockets. XHR401: E401 crystal oven socket. XV408: V408 socket.	2Z8670.33
XV401 thru XV405, XV411 thru XV413	SOCKET, electron tube: 5 cont; subminiature; rectangular shape; molded phenolic.	XV401: Socket for first oscillator tube V401. XV402: Socket for second oscillator tube V402. XV403: Socket for modulator tube V403. XV404: Socket for double tube V404. XV405: Socket for double tube V405. XV411: Socket for first audio tube V411. XV412: Socket for limiter tube V412. XV413: Socket for second audio amplifier V413.	2Z8675.107
XV406, XV407	SOCKET, electron tube: 7 cont; miniature; molded phenolic or thermosetting plastic body; mts above chassis.	XV406: V406 socket. XV407: V407 socket.	2Z8677.171
XV409, XV410	SOCKET, electron tube: 8 cont; medium octal.	XV409: Tube socket for V409. XV410: Tube socket for V410.	2Z8678-7
H453	SPRING: .035 in. dia spring steel wire; 3-1/4 turns.	Mountain tension of antenna coupler adjustment.	2Z8878-105
H496	STRAP, mounting: steel; 1-3/16 in. lg x 15/16 in. wd x 1-1/32 in. d; cad pl.	Transformer mounting strap.	2Z9052-121
H401 thru H404, H413 thru H416	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia o/a.	Fastener studs.	6Z8585-14
H405, H406, H417, H418	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia.	Studs for Airloc fastener.	6Z8585-8
H425 thru H429	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia.	Studs for Airloc fastener.	6Z8585-10
S401, S402	SWITCH, toggle: SPDT; 2 amp, 250 v ac; phenolic.	S401: TUNE-OPERATE switch. S402: Filament TEST-OFF switch.	3Z9863-12D

2. Identification Table of Parts for T-278/U (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
E401 thru E403	TERMINAL, lug: brass; tinned; .531 in. lg x .312 in. wd x .243 in. h.	Solder lugs.	3Z12073-68.3
E407 thru E409, E429, E436, E437	TERMINAL, stud: 14,000 v break-down; brass w/ phenolic base; cad pl; 9/16 in. lg x 1/4 in. dia.	E407 thru E409: Tie points in antenna filter assembly E429: Tie point for V410 screen grid resistor R443. E436 and E437: Tie points in exciter assembly.	3Z12101-9.5
E422, E423	TERMINAL, stud: molded, asbestos filled melamine; 7/8 in. lg x 5/16 in. dia.	Feedthroughs for antenna loop output adjustment E421.	3Z12073-62
E431 thru E435	TERMINAL, stud: 14,000 v break-down; 5/8 in. lg x 1/4 in. dia.	Mounting terminal studs.	3Z12101-45.1
T401	TRANSFORMER, AF: 600 ohms pri w/150 ohms tap, 60,000 ohms secd; 10 ma d-c pri cur; 500 v test v; 1-1/4 in. lg x 15/16 in. dia; ±2 db 300 to 3500 cyc.	Microphone input transformer.	2Z9631.488
Z405	TRANSFORMER, RF: pri .30 uh at 25 mc, secd .10 uh at 25 mc; 25 mc peak freq; unshielded; 1.781 in. lg x .697 in. dia max; air core; adj iron slug, screw, located on bottom.	Part of V407 plate coupling circuit.	2Z9626.73
V401, V402	TUBE, electron: pentode; subminiature r-f ampl; type 1AD4.	V401: First oscillator. V402: Second oscillator.	2J1AD4
V403, V404, V411, V413	TUBE, electron: pentode; subminiature sharp cutoff; type 5678.	V403: Modulator. V404: Doubler. V411: First audio amplifier. V413: Second audio amplifier.	2J5678
V405, V412	TUBE, electron: pentode; subminiature receiving pwr ampl; type 5672.	V405: Doubler. V412: Limiter.	2J5672
V406, V407	TUBE, electron: pentode; transmitting beam pwr ampl; type 3B4.	Doublers.	2J3B4
V408, V409, V410	TUBE, electron: pentode; transmitting beam pwr ampl; type 2E24.	V408: Doubler and driver. V409 and V410: Power amplifiers.	2J2E24

3. Identification Table of Parts for T-416/GR

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
	TRANSMITTER, radio: 152 to 174 mc; xtal controlled; 50 w; ac, 6.3 v, 60 cyc, 12.6 w 6 v, 60 cyc, 5.4 w; dc, 450 v, .250 amp, 225 v, .070 amp, 225 v, .040 amp, 2 v, .010 amp, 1.3 v, .100 amp, 1.25 v, .90 amp, 1.25 v, .200 amp; 14-1/2 in. lg, 4-1/2 in. wd, 8-9/16 in. h; Motorola Inc. part No. 201V1148.	Radio transmitter for Radio Sets AN/TRC-28 and AN/FRC-27.	2C6900-416
E532, E533	BAR, shorting: 1-19/32 in. lg x 3/8 in. wd x 15/64 in. h.	Contacts for tuning plate in final tank circuit.	2Z558-82
H541	BOLT, machine: steel; 8-32.	Testing screw for final plate tuner.	6L7032-56.3S
H546	BUSHING: brass; 1.0 in. o/a lg x .312 in. wd across flats; bushing threaded thru ctr w/8-32 thd.	Part of final plate tuner assembly.	2Z1409-340
C401, C402, C503	CAPACITOR, fixed: ceramic; 75 uuf ±10%, 500 vdcw.	C401: V402 screen grid feedback. C402: V401 screen grid feedback. C503: D-c blocking to V501 control grid.	3D9047-75
C405	CAPACITOR, fixed: ceramic; 10,000 uuf +100% -0; 500 vdcw.	V401 screen and plate decoupling.	3DA10-562
C406	CAPACITOR, fixed: ceramic; 22 uuf ±10%; 500 vdcw.	V403 plate to control grid coupling.	3D9022-65
C407	CAPACITOR, fixed: ceramic; 10 uuf ±1 uuf; 500 vdcw.	V403 plate to control grid coupling.	3D9010-226
C410	CAPACITOR, fixed: ceramic; 51 uuf ±10%; 500 vdcw.	V404 control grid d-c blocking.	3D9051-82
C411	CAPACITOR, fixed: ceramic; 47 uuf ±10%; 500 vdcw.	V404 control grid d-c blocking.	3D9047-79
C412, C413, C417, C418, C420, C421, C423, C424, C501, C504, C505, C506, C510, C511, C523	CAPACITOR, fixed: ceramic; 1500 uuf +100% -0; 500 vdcw.	C412: V404 plate and screen grid decoupling. C413: V404 screen grid bypass. C417: V405 screen grid bypass. C418: V405 plate and screen grid bypass. C420: V406 screen grid bypass. C421: V406 plate and screen grid bypass. C423: V407 screen grid bypass. C424: V407 plate and screen grid bypass.	3DA1.500-70

3. Identification Table of Parts for T-416/GR (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		C501: R-f bypass for metering jack J501. C504: Minus 22-volt bias bypass. C505: V501 screen grid bypass. C506: L502 bypass. C510: Metering jack J502 bypass. C511: V502 filament bypass. C523: V502 screen grid to cathode bypass.	
C414	CAPACITOR, fixed: ceramic; 10 uuf ±.25 uuf; 500 vdcw.	Part of Z402 network.	3D9010-227
C416, C419, C422	CAPACITOR, fixed: ceramic; 100 uuf ±10%; 500 vdcw.	C416: V405 control grid d-c blocking. C419: V406 control grid d-c blocking. C422: V407 control grid d-c blocking.	3D9100-341
C453	CAPACITOR, fixed: ceramic; 12 uuf ±10%; 500 vdcw.	Part of Z407 network.	3D9012-88
C454	CAPACITOR, fixed: ceramic; 26 uuf ±10%; 500 vdcw.	Part of Z407 network.	3D9026-1
C455	CAPACITOR, fixed: ceramic; 8 uuf ±1%; 500 vdcw.	Part of Z407 network.	3D9008-52
C512, C513	CAPACITOR, fixed: ceramic; 500 uuf +100% -0; 750 vdcw.	C512: V502 plate No. 2 bypass capacitor. C513: V502 plate No. 1 bypass capacitor.	3D9500-284
C515, C516, C518, C519, C520, C521, C522	CAPACITOR, fixed: ceramic; 1000 uuf ±20%; 750 vdcw.	C515: R-f bypass at L506A. C516: R-f bypass at L506B. C518: V502 plate bypass. C519: V501 and V502 filament bypass. C520: Bypass for V501 control grid. C521: V501 and V502 control grid bypass. C522: V501 bypass.	3DA1-370
C425	CAPACITOR, fixed: electrolytic; 2 sect.; 30 uf per sect., 400 vdcw; neg term. grounded internally.	V406 and V407 screen grid voltage filter.	3DB30-58
C426, C460	CAPACITOR, fixed: electrolytic; 1 sect.; 8 uf; 30 vdcw; neg pl grounded to case.	C426: Part of +2-volt line filter.	3DB8-240

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		C460: Part of 22-volt line filter.	
C459	CAPACITOR, fixed: electrolytic; 1 sect.; 4 uf; 60 vdcw.	Minus 22-volt bias filter.	3DB4-412
C456	CAPACITOR, fixed: mica; 240 uuf ±5%; 500 vdcw.	V413 plate control grid bypass.	3D9240-33
C463	CAPACITOR, fixed: mica; 510 uuf ±5%; 300 vdcw.	V411 d-c blocking.	3D9510-38
C408, C415, C457, C458, C461	CAPACITOR, fixed: paper; 1 sect.; 10,000 uuf ±20%; 200 vdcw.	C408: Couples plate of V413 to control grid of V402. C415: Part of antenna filter assembly Z407. C457: Couples plate of V412 to control grid of V413. C458: D-c blocking capacitor for test jack J402. C461: Couples plate of V411 to grid of V412.	3DA10-625
C409, C462	CAPACITOR, fixed: paper; 100,000 uuf ±20%; 200 vdcw.	C409: Screen grid bypass for V403. C462: Plate decoupling for V411.	3DA100-1172
C403, C404, C508	CAPACITOR, variable: air; plate meshing type; 75 uuf max, 6 uuf min; 850 v ac peak.	C403: Y401 crystal resonance control. C404: Y402 crystal resonance control. C508: V502 control grid coupling.	3D9075V-33
C502	CAPACITOR, variable: air; 23 uuf max, 4 uuf min; 600 v ac peak.	V501 control grid coupling.	3D9023V-8
C507	CAPACITOR, variable: air; single sect.; 23 uuf max, 4.5 uuf min; 1200 v rms peak.	V501 plate loading control.	3D9023V-16
C517	CAPACITOR, variable: air; 1 sect.; 23 uuf max, 4 uuf min; 600 v rms peak.	Antenna coupling control.	3D9023V-5
E524	CLAMP, electrical: brass; screw type; 1-1/2 in. lg x 3/8 in. dia.	Clamp for right-hand side of V502 plate.	2Z2642.845
E527	CLAMP, electrical: brass; screw type; 1-1/2 in. lg x 3/8 in. dia.	Clamp for left-hand side of V502 plate.	2Z2642.846
H440, H441	CLAMP, electrical: 13/16 in. lg x 1/2 in. wd x 5/16 in. h.	Cable clamps.	8P1-101-1
H497, H498, H501	CLAMP, electrical: 11/16 in. lg approx x 1/2 in. wd x 7/16 in. h.	Cable clamps.	8P1-101-2

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
E521	CLIP, electrical: brass; 2-5/8 in. lg x 3/8 in. dia x 15/16 in. wd.	Clip for V501 grid.	2Z2712.384
H480 thru H487	CLIP, electrical: steel and brass; 1-11/32 in. lg x 5/8 in. wd o/a x 5/32 in. thk.	Hold tubes in place.	2Z2712.381
L401	COIL, RF: 2 uh at 250 kc, 25 ohms dc; 430 turns #38 AWG copper cond, 15/32 in. lg x 9/32 in. dia.	Oscillator plate load coil.	3C1084B-88
L413	COIL, RF: 6 turns, #18 AWG, copper cond, 1 wdg, .258 in. OD approx x .937 in. lg.	Part of antenna input network Z407.	3C1084B-87
L414	COIL, RF: 5 turns, #18 AWG, copper cond, .267 in. od x .937 in. lg.	Part of antenna input network Z407.	3C1084B-86
L415	COIL, RF: 3 turns, #18 AWG, copper cond, 1 wdg, .290 in. od x .789 in. lg.	Part of antenna input network Z407.	3C1084B-85
L501	COIL, RF: .118 uh at 25 mc; #14 AWG, copper cond, 1 wdg, 5/8 in. lg x 33/64 in. dia approx.	Part of V501 tube input circuit.	3C1084B-83
L502	COIL, RF: #11 AWG, copper cond, 1-7/8 in. lg x 23/32 in. wd.	Coupling between plate V501 driver and control grid V502 power amplifier.	3C1084B-78
L503, L505	COIL, RF: 30 turns, #26 AWG, copper cond, 1 wdg, 5/8 in. lg x 3/16 in. dia.	L503: Plate choke for V501 tube. L505: grid bias r-f choke of V502 tube.	3C362-101
L504	COIL, RF: .032 in. thk x .250 in. wd, 2-11/64 in. lg x 3/4 in. wd x 1/4 in. h.	Part of V502 tube input circuit.	3C1084B-84
L507	COIL, RF: #14 AWG, copper cond, 1-7/8 in. lg x 1-1/16 in. wd.	Couples transmitter output to antenna.	3C1084B-89
Z401	COIL, RF: 8.2 uh at 7.9 mc, 1.1 ohms dc resistance; 60 turns, #34 AWG, copper cond, 1.593 in. lg x .263 in. dia approx; contains one RC10BF103K resistor.	V403 plate load.	3C1084B-82
Z402	COIL, RF: 8.2 uh at 7.9 mc, 1.1 ohms dc resistance; 60 turns, #34 AWG, copper cond, 1.593 in. lg x .263 in. dia; contains one RC10BF103K resistor and one CC20PH100F capacitor.	V404 plate load.	3C1084B-80
Z403	COIL, RF: 2.8 uh at 7.9 mc, .33 ohms dc resistance; 30 turns, #32 AWG, copper cond, 1.593 in. lg x .263 in. dia approx; contains one RC10BF472K resistor.	V405 plate load.	3C1084B-79
Z404	COIL, RF: .73 uh at 25 mc, .016 ohms dc resistance; 13-1/2 turns, #22 AWG, copper cond, 1.593 in. lg x .263 in. dia approx.	V406 plate load.	3C1084B-81

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
J401 thru J404	**CONNECTOR**, receptacle: 1 female round cont; black, phenolic; 11/16 in. lg x 37/64 in. wd.	J401: Test point for control grid of V404. J402: Test point for control grid of V405. J403: Test point for control grid of V406. J404: Test point for control grid of V407.	2Z3055-38
P401	**CONNECTOR**, receptacle: 32 male round cont; 1-7/32 in. lg x 3-3/8 in. wd x 1-11/16 in. h; 28-10 amp, 2-40 amp, 2 coaxial-2 amp, 110 v ac.	Connects transmitter to Electrical Equipment Cabinet CY-938/VRC.	2Z3046.37
P402, P403	**CONNECTOR**, plug: 1 male round cont; 39/64 in. lg x 21/64 in. dia; 50 ohms nom impedance.	Coaxial connectors.	2Z7390-88
A 509	**COVER**: aluminum allow; 6-23/64 in. lg x 4-1/16 in. wd x 33/64 in. d.	Protective front cover for transmitter.	2Z3351-540
H536, H537	**FASTENER**, spring lock: steel; 3/4 in. lg x 5/8 in. wd x 1/2 in. h o/a.	Hold covers in place.	6Z3810-16.30
E512	**INSULATOR**, stand-off: steatite; one No. 6-32 thd tapped mtg hole at ea end.	Support for coil L502.	3G3501-06.3
E513, E519	**INSULATOR**, stand-off: steatite; one No. 6-32 thd tapped mtg hole at ea end.	E513: Coil form for L501. E519: Grid line support for V502.	3G3501-08.1
E522, E523, E525, E526	**INSULATOR**, stand-off: steatite; one No. 6-32 thd tapped mtg hole at ea end.	E522, E523: Supports for V502 plate line. E525, E526: Supports for V501 plate line.	3G3501-04.2
E514 thru E518, E520, E528, E529	**INSULATOR**, washer: neoprene; circular flat shape.	Insulating washers.	3G385-152
H442	**KNOB**: round; steel; .500 in. dia x .250 in. thk.	Part of lock-in assembly.	2Z5822-807
L506A, L506B	**LINE SECTION**, RF transmission: copper; silver and rhodium pl; L shaped; 2-31/32 in. lg x 1/4 in. dia x 4-1/4 in. h.	Part of final tank circuit.	2Z10008-184
HR501	**OVEN**, crystal: 1 xtal unit; 75° C min oven temp, -40° C ambient temp, ±4° C; ac, 6.3 v or 24 v, 60 cyc, single ph, 26 w; dc, 6.3 v or 24 v, 405 ma; 1-11/16 in. h x 1-1/4 in. dia.	Constant temperature crystal oven.	2Z6897-7
H547	**PIN**, wrist: brass, nickel pl; 1.125 in. lg x .252 in. dia max wd, .250 in. wd flatted ctr area drilled and taped 8-32.	Bushing for output loop assembly.	6L3944-20BN
C514A, C514B	**PLATE**, capacitor: brass; 1 in. dia plate x 1-1/16 in. lg.	Capacitor plates in final tank circuit.	2Z7090.340

3. Identification Table of Parts for T-416/GR (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
K401	RELAY, solenoid: normally closed, single break, dc, 115 v, 2 amp; 52 ohms resistance, 6 v dc, 111 ma; 2-15/16 in. lg x 2-3/8 in. wd x 1-1/4 in. h.	Antenna relay.	2Z7599A-450
R401, R402, R462	RESISTOR, fixed: comp; 47,000 ohms ±10%; 1/2 w.	R401, R402: Part of V401 and V402 input balance. R462: V411 plate voltage dropping.	3RC20BF473K
R403, R404, R411, R418, R423, R451, R474	RESISTOR, fixed: comp; 100,000 ohms ±10%; 1/2 w.	R403: V403 suppressor grid bypass. R404: V404 suppressor grid bypass. R411: V404 screen grid voltage dropping. R418: V406 control grid bleeder. R423: V407 control grid bleeder. R451: V413 screen and control grid voltage dropping. R474: V411 screen dropping.	3RC20BF104K
R405, R420, R425	RESISTOR, fixed: comp; 4700 ohms ±10%; 1/2 w.	R405: V401 and V402 plate voltage dropping. R420: V406 screen grid voltage dropping. R425: V407 screen grid voltage dropping.	3RC20BF472K
R406, R413, R457, R463	RESISTOR, fixed: comp; 150,000 ohms ±10%; 1/2 w.	R406: V403 audio input coupler. R413: V403 and V405 control grid bias dropping. R457: V412 plate voltage dropping. R463: V411 plate voltage dropping.	3RC20BF154K
R407, R409, R415, R419, R424, R453, R460, R470	RESISTOR, fixed: comp; 1 meg ±10%; 1/2 w.	R407: V405 control grid bias. R409: V404 control grid bias. R415: J402 voltage dropping. R419: J403 voltage dropping. R424: J404 voltage dropping. R453: V413 feedback limiter. R460: V412 control grid bias.	3RC20BF105K

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		R470: J401 voltage dropping.	
R408, R412	RESISTOR, fixed: comp; 10,000 ohms ±10%; 1/2 w.	R408: Part of Z401 network. R412: Part of Z402 network.	3RC20BF103K
R410	RESISTOR, fixed: comp; 10 ohms ±10%; 1 w.	V404 filament control.	3RC30BF100K
R414	RESISTOR, fixed: comp; 680,000 ohms ±10%; 1/2 w.	V405 control grid bias.	3RC20BF684K
R416	RESISTOR, fixed: comp; 22,000 ohms ±10%; 1/2 w.	V405 screen grid voltage dropping.	3RC20BF223K
R417	RESISTOR, fixed: comp; 4700 ohms ±10%; 1/2 w.	Part of Z403 network.	3RC20BF472K
R421, R422, R426, R427, R430, R431, R505	RESISTOR, fixed: comp; 1500 ohms ±10%; 2 w.	R421, R422: V406 screen grid voltage dropping. R426, R427: V407 screen grid bias voltage dropping. R430, R431: V406 and V407 screen grid bias voltage dropping. R505: V502 screen grid bias voltage dropping.	3RC42BF152K
R428, R429	RESISTOR, fixed: comp; 2200 ohms ±10%; 2 w.	V406 and V407 screen grid voltage dropping.	3RC42BF222K
R432, R433	RESISTOR, fixed: comp; 4700 ohms ±10%; 2 w.	V406 and V407 screen grid voltage dropping.	3RC42BF472K
R434	RESISTOR, fixed: comp; 1000 ohms ±10%; 1 w.	Plus 25-volt bleeder.	3RC30BF102K
R450, R459, R467	RESISTOR, fixed: comp; 220,000 ohms ±10%; 1/2 w.	R450: V413 output dropping. R459: V412 control grid bias voltage dropping. R467: V411 control grid bias voltage dropping.	3RC20BF224K
R454, R510	RESISTOR, fixed: comp; 15,000 ohms ±10%; 1/2 w.	R454: Minus 22-volt voltage dropping at C459. R510: Minus 22-volt bias dropping.	3RC20BF153K
R456, R458, R502	RESISTOR, fixed: comp; 470,000 ohms ±10%; 1/2 w.	R456: V413 control grid coupler. R458: V412 screen grid voltage dropping. R502: Metering jack J501 voltage dropping.	
R455, R461	RESISTOR, fixed: comp; 6800 ohms ±10%; 1/2 w.	R455: Minus 22-volt dropping at C459.	

3. Identification Table of Parts for T-416/GR (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
		R461: Minus 22-volt dropping at C460.	
R464	RESISTOR, fixed: comp; 3300 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF332K
R465, R466	RESISTOR, fixed: comp; 100 ohms ±10%; 1/2 w.	V411 cathode voltage dropping.	3RC20BF101K
R468, R469	RESISTOR, fixed: comp; 68,000 ohms ±10%; 1/2 w.	R468: V413 feedback control. R469: T401 secondary impedance balance shunt.	3RC20BF683K
R471, R472	RESISTOR, fixed: comp; 1000 ohms ±10%; 2 w.	R471: V406 screen grid voltage dropping. R472: V407 screen grid voltage dropping.	3RC42BF102K
R501	RESISTOR, fixed: comp; 22,00 ohms ±10%; 1 w.	Minus 22-volt bias dropping to V501 control grid.	
R503	RESISTOR, fixed: comp; 47,000 ohms ±10%; 1 w.	V501 screen grid voltage dropping.	3RC30BF473K
R504	RESISTOR, fixed: comp; 3300 ohms ±10%; 1 w.	Minus 22-volt bias dropping to control grids of V502.	3RC30BF332K
R506	RESISTOR, fixed: comp; 22,000 ohms ±10%; 2 w.	V502 screen grid bias dropping for tuning purposes.	3RC42BF223K
R507 thru R509	RESISTOR, fixed: comp; 10 ohms ±5%; 1/2 w.	Part of V502 plate balancing network.	3RC30BF100J
R452	RESISTOR, variable: comp; 100,000 ohms ±20%; 1/4 w.	Transmitter modulation deviation control.	3RV51057
H435 thru H438, H463, H468 thru H473, H538, H539	RETAINER, fastener stud: steel, cad pl; 1 in. lg x 33/64 in. wd x 3/16 in. thk.	Retainers for cover fastener studs.	6Z7852-9
H488 thru H495	RING, retainer: brass; .460 in. lg x .264 in. wd x .012 in. thk o/a.	Holds tube sockets in chassis.	2Z7858-343

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
H542 thru H544, H550 thru H552	RING, retainer: carbon steel, cad pl; .282 in. OD x .114 in. ID x .025 in. thk.	H542: Final plate tuning shaft retaining ring. H543, H544, H550, H551, H552: Retaining rings.	2Z7858-351
H549	RING, retainer: carbon spring steel, cad pl; .112 in. ID x 1/8 in. max OD x .010 in. thk.	Retaining ring for output tuning shaft.	2A3171.1-27
H553	SHAFT: steel; 3.547 in. lg x .146 in. dia max o/a.	Tuning shaft for output coupling link.	2Z8203-751
O503, O504	SHAFT: plastic; 1 in. lg x .253 in. dia max.	Shaft extension.	2Z8203-753
O501, O502	SHAFT, coupling: brass, nickel pl; cylindrical shape; 3/4 in. lg x 1/2 in. dia.	Shaft coupling.	2Z8203-752
E406	SHELL, electrical connector: brass; cylindrical; .750 in. lg x .250 in. OD x .152 in. and .204 in. ID.	Conduit and grounding connection for r-f cable.	2Z8276-113
E501, E502	SHIELD, electron tube: copper or brass; .930 in. dia x 1-3/4 in. h.	Tube shields.	2Z8304.276
H540	SHIM: aluminum alloy; square; 2-13/16 in. lg x 2-13/16 in. wd x .064 in. thk o/a.	Tube socket shim.	2Z8320-88
XV401 thru XV405, XV411 thru XV413	SOCKET, electron tube: subminiature; .350 in. lg x .218 in. wd x .281 in. h.	XV401: Socket for first oscillator tube V401. XV402: Socket for second oscillator tube V402. XV403: Socket for modulator tube V403. XV404: Socket for double tube V404. XV405: Socket for double tube V405. XV411. Socket for first audio tube V411. XV412: Socket for limiter tube V412. XV413: Socket for second audio amplifier V413.	2Z8675.107
XC425, XHR-401, XV408	SOCKET, electron tube: 8 cont; 1-7/8 in. lg max x 1-3/8 in. wd max x 25/32 in. h max.	XC425: C425 capacitor socket. XHR401: E401 crystal oven socket. XV408: V408 socket.	2Z8670.33
XV501	SOCKET, electron tube: med; 1-7/8 in. lg max x 1-3/8 in. wd max x 25/32 in. h max.	Socket for V501.	2Z8678.326
XV502	SOCKET, electron tube: round; 2.312 in. lg x 2.312 in. wd x .968 in. h.	Socket for V502 power-amplifier tube.	2Z8677.221
H548	SPRING: .035 in. dia spring steel wire; 3-1/4 turns.	Maintains antenna coupler adjustment.	2Z8878-105

3. Identification Table of Parts for T-416/GR (contd)

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
H502 thru H505, H514 thru H517	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia.	Studs for Airloc fasteners.	6Z8585-14
H506, H507, H518, H519	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia.	Studs for Airloc fasteners.	6Z8585-8
H526 thru H530	STUD: steel, cad pl; 33/64 in. lg x 11/64 in. dia.	Studs for Airloc fasteners.	6Z8585-10
H555, H556	STUD: steel, cad pl; .516 in. lg x .260 in. dia.	Studs for Airloc fasteners.	6Z8585-7
S501, S502	SWITCH, toggle: SPDT; 2 amp, 250 v ac; 1-9/32 in. lg max x 23/32 in. wd max x 23/32 in. h max.	S501: Test switch. S502: TUNE-OPR switch.	3Z9863-120
TB401	TERMINAL BOARD: 34 term., midget turret type; 5-3/8 in. lg x 1-1/2 in. wd x 9/32 in. h.	Terminal board.	3Z770-34.26
TB402	TERMINAL BOARD: 34 term., midget turret type; 5-3/8 in. lg x 1-1/2 in. wd x 9/32 in. h.	Terminal board.	3Z770-34.27
TB403	TERMINAL BOARD: 16 term., midget turret type; 4 in. lg x 1-15/16 in. wd x 15/32 in. h.	Terminal board.	3Z770-16-84
TB404	TERMINAL BOARD: 16 term., midget turret type; 4 in. lg x 1-15/16 in. wd x 15/32 in. h.	Terminal board.	3Z770.16.85
TB501	TERMINAL BOARD: 11 term., 3 in. lg x 1 in. wd x .062 in. thk.	Test point assembly.	3Z770-11.39
E407 thru E409, E436, E437, E504 thru E509	TERMINAL, stud: 14,000 v break-down; brass w/phenolic base; cad pl; 9/16 in. lg x 1/4 in. dia.	E407, E408, E409: Tie points for antenna filter assembly. E436, E437: Tie points in exciter assembly. E504, E505, E506, E507, E508, E509: Tie points in final assembly.	3Z1210-9.5
E431 thru E435	TERMINAL, stud: 14,000 v break-down; 5/8 in. lg x 1/4 in. dia.	E431: Mounting terminal. E432, E433, E434, E435: Terminal studs.	3Z12101-45.1
E503	TERMINAL, stud: brass; 1-1/32 in. lg x 5/16 in. dia.	Double-ended terminal lug.	3Z12101-22.20
E510, E511	TERMINAL, stud: 22,000 v; 7/8 in. lg x 1/4 in. wd.	Insulated stand-off terminals.	3Z12101-9.11

Ref. symbol	Name of part and description	Function of part	Signal Corps stock No.
E534, E535	TERMINAL, stud: 7/8 in. lg x 5/16 in. dia.	Feedthrough for antenna loop output adjustment.	3Z12073-62
T401	TRANSFORMER, AF: 600 ohms pri w/150 ohms tap, 60,000 ohms secd; 10 ma pri cur; 500 v test; 1-1/4 in. lg x 15/16 in. dia; ±2 db 300 to 3500 cyc.	Microphone input transformer.	2Z9631.488
Z405	TRANSFORMER, RF: 2 wdg, pri .30 uh at 25 mc, secd .10 uh at 25 mc; 25 mc peak frequency; 1.781 in. lg x .697 in. dia max.	Part of V407 plate coupling circuit.	2Z9626.73
V401, V402	TUBE, electron: pentode; subminiature r-f amplifier; JAN type 1AD4.	V401: First oscillator. V402: Second oscillator.	2J1AD4
V403, V404, V411, V413	TUBE, electron: pentode; subminiature sharp cutoff; JAN type 5678	V403: Modulator. V404: Doubler. V411: First audio amplifier. V413: Second audio amplifier.	2J5678
V405, V412	TUBE, electron: pentode; subminiature receiving power amplifier; JAN type 5672.	V405: Doubler. V412: Limiter.	2J5672
V406, V407	TUBE, electron: pentode; transmitting beam power amplifier; JAN type 3B4.	Doublers.	2J3B4
V501	TUBE, electron: tetrode; transmitting beam power tetrode; JAN type 2E26.	R-f power amplifier driver.	2J2E26
V502	TUBE, electron: transmitting dual tetrode.	R-f power amplifier.	2J5894

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